THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 30. Thursday, July 10, 1924. No. 412.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Investigation Required	23
The Foundry Competition	24
Porosity in Cast Iron	25
Sand Conservation and Reclamation	27
The British Cast-Iron Research Association: Its Present Work and Future Development	28
The Effect of Casting Temperature on the Physical Properties of a Sand-cast Zinc Bronze	32
The Peacock Moulding Machine	33
A Note on Non-metallic Inclusions in Metals, with Special Reference to Aluminium	34
Patternshop Belts	35
Economy in Foundry Practice	38
American Work on Testing of Foundry Sand	40
Trade Talk	41
Personal	41
Obituary	41
Company News	41
Gazette	41
Contracts Open	41
Iron and Steel Markets	42
Correspondence	42

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1924-25, R. O. Patterson, Blaydon-on-Tyne.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield: R. Village, Albion Foundry, Whittington Moor, near Chesterfield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, 37, Melville Road.
West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.

Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Investigation Required.

In the course of a lecture read before the visitors to the recent International Foundry Trades Exhibition at Birmingham, Dr. S. Werner, the President of the German Foundrymen's Association, stated that a new and satisfactory method had been devised in Germany for the estimation of oxygen in cast iron. One might thus reasonably assume that the method will be equally applicable to steel, copper, nickel and, in fact, practically all metals. At the moment, we have not learnt whether it is now possible to state whether and how much oxygen is present in the free or combined state. Such knowledge may help in the analysis of metals and alloys, for unless special precautions are taken it is quite easy to return more than the actual quantity of an element in a metallic powder, aggregate or alloy, if it so happens that it is contaminated with oxide.

However, it is not so much the assaying itself that appeals to us, but rather the ascertaining of whether and to what extent the element is detrimental or beneficial to the useful properties of commercial alloys and metals. In steel, an excess is thought by many to be responsible for blowholes, especially in cauliflower-topped ingots, whilst a few hold that its almost entire absence is responsible for impaired fluidity. In cast iron one school of thought states definitely that owing to the presence of a relatively large amount of silicon it cannot be present, and would ascribe all blow-holes to sulphur and other causes. Another section insists that a certain amount of oxygen is beneficial.

The most important result which can be expected from the development of a reliable and reasonable method of estimating oxygen in cast iron is that once its influence is established then perhaps by a careful correlation of results *with process details*, it may be possible to prepare a series of alloys with increasing proportions of the gas. Then it is reasonable to conclude that its control would be well on the road to solution.

Perhaps one gains the best perspective of the behaviour of gases on iron-carbon alloys when manufacturing dead-mild steel. Such an alloy has a very high casting temperature, and in a Swiss works this was emphasised on account of the necessity to run the metal into a large number of really small ingots. From experience, it can be stated that such a steel has a very delicate equilibrium, as is sometimes exhibited by, say, the first two and the last two moulds rising, whilst perhaps a dozen in between will be satisfactory. The Swiss works referred to above makes a serious effort to alter the equilibrium in the furnace by heating to a high temperature and then cooling in the furnace and finally re-heating to a safe casting temperature. After an inspection of many tons of ingots we were satisfied that the problem of casting of properly killed, dead-mild steel ingots by the hen-and-chickens method had been solved by the assumption that gas could be liberated from steel by a change in the equilibrium.

In a French steel works making steel for wine-cask strips, apparently but little notice was taken of the gas content. Ingot moulds were but half-filled to allow for boiling; the composition, however, was controlled so as to give a very weldable steel. Though most of the ingots were of a honeycomb character, there was a high yield from the mill, and the final product was in every way suitable for its purpose. These two examples indicate in a small way the necessity for British metallurgists to examine the German method for estimating oxygen, and if found workable, to test regularly for this gas, so that information may become available for its control together with other gases.

The Foundry Competition.

The second National Foundry Competition held at Bingley Hall, Birmingham, again reflects great credit on the organisers and judges, some of the latter putting in as much as forty hours of valuable time.

Although the number of entries was not so great as in the previous competition, it was agreed that they made up in quality for lack of numbers.

Class A.—Core Making.

Light Castings.—Oil sand for candidates under 21:—

S. Mason, first prize; P. E. Linden, second prize; V. C. Cumming, extra prize. All points considered, there was not much to choose between them. They produced satisfactory cores in reasonable time. In the same section cores made in ordinary sand, by candidates over 21, experience gave better results. J. Hulston, first prize; H. Brookes, second prize. Both winners did very good work.

Medium Castings.—Cores in ordinary sand. No restriction as to age:—

The prize-winners in this section gave a fairly good account of themselves, T. Perry securing first prize and Miss Smallwood second prize.

Heavy Castings.—No restriction as to age:—

This section produced two excellent core-makers as winners. J. A. Spare, first prize; G. H. Price, second prize.

In the above core-making sections many competitors failed to reach a high standard. In some cases little or no provision was made to conduct away gases which would be generated in the oil sand cores (although quite a large number of moulders and core-makers neglect vents in this material). Others would omit to place in the core a necessary piece of wrought iron to strengthen a particularly weak place. Many others lost on time. In the same class, but for adults, with cores made in ordinary sand experience led to fewer mistakes in this connection. Competitors were placed more on the score of time, but several men rammed the cores too hard, which would create venting trouble and inability to extract core from box without some injury. One competitor spoke very distressingly of his luck. He had failed to notice that sand had lodged under several loose portions of the core-box, preventing him effectively jointing the core. Another competitor had his core irons springing, so that when he removed the top half of the core-box a huge crack appeared along the side of the core. He quickly rubbed his hand across the crack, but the keen-eyed judge had noted the fault, and used his ever-ready pencil accordingly.

Class B.—Moulding.

(No restriction as to age.)

Floor Moulding.—E. L. Porter, first prize; C. Goodman, second prize; F. F. Fereday, third prize; T. Hopcroft, extra prize. Some difficulty was experienced in placing them in the order named. Very good work was done by the four winners.

Two-part Moulding.—L. Walters, first prize, C. Meredith, second prize; E. A. Rollason, third prize; extra prizes went to A. S. Turner, H. W. Hall, W. C. Rabin. This section proved to be the most interesting one of the whole competition. There was much to record about the first and second prize winners. L. Walters, we understand, is shortly to leave this country for the States. Thus another skilled man leaves our shores. A worm mould was one of the tests in this section. When Walters had formed the parting of the mould (the most difficult part of the whole job), placed paper on inclined and almost vertical joints, he finished off by vigorously shaking the parting-dust bag on the horizontal joint, creating quite a big cloud of white dust. At this stage many of the judges had detached themselves from their charges to watch this particular man. As the judges discreetly retired beyond this cloud, the spectators were highly amused. C. Meredith also provided amusement and interest. He had come prepared for all emergencies. Each of his pockets was stuffed with materials which might be needed, although there was an abundance of necessary materials provided. As the job proceeded, from time to time his hand was deftly shot into first one pocket and then another, extracting sprigs, waxed paper, parting sand, nails to act as gaggers, and finally plumbago to face the mould. E. A. Rollason, the winner of the third prize, also shaped very well. When he reaches the age of the first and second prize winners he will, no doubt, give them a good run for position.

Three-part Moulding.—This section provided only mild interest. W. Lloyd, first prize, proved to be a very neat worker; W. Brant, second prize, and L. Ramsbottom, third prize, ran very close.

False-core Moulding.—F. Beckingham, who was awarded the prize in this section, was a big man with a light touch. His work was real art. He made moulds of two figures, one of a horse and the other head and shoulders of a man with complicated head-covering. Many false cores (drawbacks) were needed. One would need to be born with fineness of touch and a good eye to excel in this special branch of moulding. Mr. Beckingham received many congratulations.

Competitors in floor moulding failed to reach the top positions because of important mistakes, such as: Insufficient venting of bottom side of mould; not setting enough irons to support cods of sand; face sprigging opposite in-gate entrance to prevent scabbing and erosion of mould; trying top box on after joint had been made instead of before. Result in one case joint had to be scratched and built up higher. Some of the moulds were beautifully finished, but experience would show that had metal been poured into these green sand moulds where the venting, ramming and sprigging had been neglected, nothing but an unsightly or scrap casting would result.

In the two-part moulding the chief failures were due to: Inability to form a correct joint and omitting to put a small gas-relief riser on the thin upstanding cavities of the mould.

With the three-part moulding important mistakes were: Neglect to put fillets on thin brackets; loosely ramming mould; and omitting to place down-gate stick in box before commencing ramming. To push a tube through the sand after ramming up means that one might get a rough runner opening, and sand may be washed by the metal into the mould.

Class C.—Patternmaking.

The blue ribbon prize of the pattern-making section was secured by F. Atkin. The design of the pattern selected was a T—pipe and core-box. His work was excellent. He made the pattern in halves with loose flange pieces with a view to making a metal plate-pattern. He included core-box and a pattern attached to the board for making cast core irons.

(For competitors over 21 years of age.)

W. T. Leek, first prize; T. B. Jones, second. The design of the pattern selected was a hand-wheel with dished arms. W. T. Leek produced a good job for production. He constructed a plate pattern so that one side would produce two castings in one box. T. B. Jones made a free pattern with part of the rim over the undercut portion loose.

(For competitors under 21 years of age.)

J. W. Sims, first prize; T. V. Upton, second prize; S. T. Essex, third prize; W. T. Grew, fourth prize; A. Henderson, fifth prize. J. W. Sims selected the hand-wheel, and made a good production job by making a plate pattern to make one casting in each box with core-box to form the dished-out portion. T. V. Upton was also good.

(For Technical School Students.)

F. W. Evans, first prize; W. J. Sanders, second prize. The work was excellent, and in some respects superior to either of the other sections.

All competitors, both winners and losers, are to be congratulated on the spirit in which they tackled the work.

The winners of the first prize in each section will also receive a diploma from the Birmingham Chamber of Commerce. This diploma should prove of more value than the money prize which goes with it.

Such competitions cannot fail to be of benefit to the foundry trade and the nation at large. If carried on more regularly it might quicken the interest of boys about to choose an occupation, and concentrate the attention of foundry owners and managers to the special abilities of these successful competitors with a view to promotion.

Porosity in Cast Iron.

By Arthur Marks, F.I.C., A.M.I.Mech.E. (Metallurgist to A. Harper, Sons & Bean, Ltd.)

The subject of porosity in cast iron has been considered and investigated by many writers, both from the theoretical and practical point of view. Only as recently as this spring local foundrymen had the pleasure in Birmingham of hearing one of the leading French foundrymen—M. Ronceray—on this question, giving an account of the influence of gas on porosity. It may be of use to practical foundrymen to consider the whole question.

Cast iron is a term which covers a large variety of materials, the essential constituents of which, from the foundry point of view, may be considered to be graphite and ferrite.

Broadly speaking, when considering cast iron, its common properties may be visualised, if it is thought of, as a type of concrete in which the aggregate consists of a large number of particles or shavings of graphite or carbon cemented together with iron (ferrite), the latter being more or less pure.

Graphite Porosity.

Thus the first type of porosity which may be found in a casting is at once apparent, and the porosity of the cast iron will depend upon the ratio of the graphite present to the ferrite.

This is the porosity which the foundryman generally tackles first in considering any type of casting he proposes to make, *e.g.*, he adjusts the openness or closeness of his mixture to suit the thickness of the casting and the hydraulic tests to which it may have to be subjected.

The maximum variations which he has to meet in practice may be visualised if we compare a soft common iron casting with; say, a closely chilled Diesel engine, fuel-pump casting which will have to stand a test pressure up to 1,000 lb. per sq. in.

A mixture for a common casting in a general foundry would consist of 40 to 60 per cent. No. 3 iron, with 60 to 40 per cent. of returned scrap such as runner heads, etc. Taking mean figures such an one might be:—

	T.C.	Gr.	C.C.	Si.	S.	P.	M.
Scotch No. 3 50% ..	3.71	3.51	0.2	3.31	.034	.956	1.79
Scrap 50% ..	3.4	3.0	0.4	2.5	.05	.8	1.1
Cald. analysis ..	3.55	3.25	.30	2.9	.042	.518	1.40
Analysis	3.45	3.3	.31	2.4	.042	.518	1.0

This will be a reasonably close casting of ordinary type. For a very thin casting where large cores are concerned, and the contraction is great compared with the thickness of the metal, it is necessary to introduce more graphite and use a more open mixture, such

	T.C.	G.C.	C.C.	Si.	S.	P.	M.
Scotch iron No. 1, 40%	3.65	3.5	0.15	3.5	0.025	0.6	1.0
,, No. 3, 30%	3.35	2.85	0.5	2.0	0.35	0.75	1.1
Scrap ,, 30%	3.7	3.4	0.3	2.5	0.06	0.58	0.7
Cald. analysis.. ..	3.57	3.27	0.3	2.75	0.038	0.63	0.94
Actual Analysis ..	3.75	3.4	0.35	2.65	0.05	0.64	0.74

In a job of this type it is frequently necessary to draw the cores almost immediately after casting.

As a contrast we may consider a close grained cylinder liner which requires to have a minimum of graphite in it to give wearing qualities and closeness of grain to maintain compression pressures of high order. Such an iron may be made up from No. 3 Scotch, 15 per cent.; No. 4 English, 25 per cent.; steel, 15 per cent.; white iron, 25 per cent.; and hard scrap, 20 per cent., giving, on analysis:—T.C., 3.4; G.C., 2.5; C.C., 0.9; Si, 0.5; S, 0.09; P, 0.30; and Mn, 0.95 per cent.

The low percentage of graphite gives an exceedingly "close" metal.

The above example illustrates the use of steel for the purpose of reducing the graphite content and closing the grain. This also toughens the iron and increases its tensile strength; such a mixture gives regularly 16 to 17 tons per sq. in. tensile.

Shrinkage Porosity.

Having considered how graphite affects the porosity directly we may look at the question of its indirect effect. Since the density of graphite is about 2.2, its replacements of iron in a mixture, even when only of the order of 0.2 to 0.4 per cent., means a considerable volume effect as compared with iron which it replaces and which has a density of 7.6 to 7.9. Thus the actual density of the cast iron is reduced to the order of 7.2 by the presence of graphite, and its influence on shrinkage is important. It is usual to increase the silicon content and thus turn out of combination more graphite for a casting with large bosses and thin walls. This is in direct contrast to the reduction of the graphite in order to reduce the "grain" porosity between the graphite plates. There are, however, limitations to this method, and an actual reduction of the quantity of graphite can be effective in reducing shrinkage porosity.

For example, a thin-walled casting containing large bosses was found to contain shrinkage porosity when cast in the following composition:—Graphite, 3.4; combined carbon, 0.33; and silicon, 2.75 per cent., whilst when cast in a harder metal, graphite, 3.0; combined carbon, 0.51; and silicon, 2.07 per cent., in which the quantity of graphite was reduced, the shrinkage porosity was absent.

Thus it is seen that whilst it is of advantage at times to prevent shrinkage porosity by taking advantage of the expansion of cast iron by the formation of graphite there is a limit beyond which the contraction of the higher graphite metal will result in excessive solid shrinkage.

The excess graphite is also frequently accompanied by increased dissolved gas, and this type of porosity is usually associated with gas holes. It then becomes difficult at times to lay down the exact cause of the trouble, and consequently difficult to decide which way to move in order to overcome the trouble.

Gas Porosity.

Some writers have recently attributed all porosity found in intricate castings as due to gas, either from the mould or from the metal. It can readily be understood that where a thin wall of metal expands into a boss, with, say, only horizontal outlets for gas, there will be a tendency for gas to accumulate and be trapped owing to the reduced rate of flow of the metal into those parts. Risers or whistlers are put in the mould to overcome the trouble. Sometimes these are ineffective, due to the flow of the metal being greater than the flow of the gas, and since the thick junctions of the sections of metal cool much more slowly than the thin sections, the shrinkage of the latter is "fed" from the hot section, particularly if there is present in the thick junction an expansible volume of gas with the metal.

Direct "blows" of the mould into the metal can usually be detected where they occur in castings and "blowing" into the metal can be satisfactorily overcome by attention to the quality of the facing sand and the correct ramming of the mould. Porosity of this type is usually just below the skin of the casting and frequently the metal "recovers," *i.e.*, is hot enough to feed the blow when the pressure of the gas has fallen by percolation through the mould. In places where the metal is thin it sets, and no recovery is possible, hence in casting thin sections of metal it is essential to give greater attention to the escape of gases from the mould during casting. It is frequently thought that each type of porosity can be recognised, but it is exceedingly difficult to settle in some cases whether an example of porosity is due to a "draw" or to gas. In many cases the oxidation colours will show the cause as due to gas, and for this reason many cases of porosity, due to non-oxidising gases, are set down to "draws" whereas their true cause is gas. The frequent use of a hand microscope will assist the foundryman to detect these cases, and the foundryman should be on his guard against attributing "draws" invariably to metal. In the same casting he will see very thick bosses quite solid, whereas at the junction of several sections of metal he will find a so-called "draw." Tackling these "draws" on the bases of their being produced by trapped gas will usually eliminate the trouble.

Dirt Porosity.

Porosity due to dirt is one of the most common types of porosity. The dirt may come either from

XUM

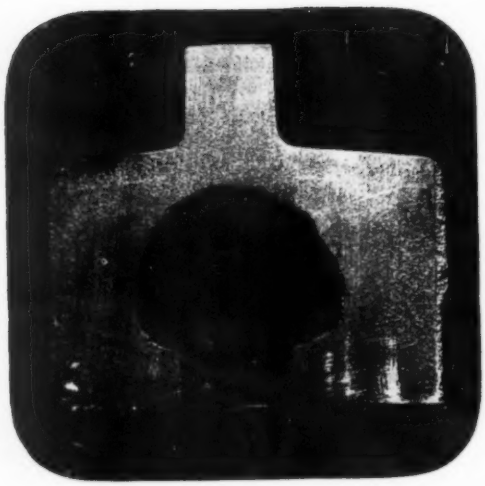


Fig. 1.—Casting showing Draw due to the Metal and Gas.

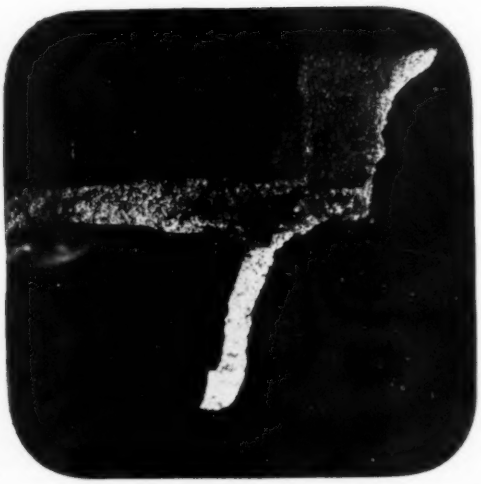


Fig. 4.—Casting showing Defect due to Trapped Gas at Junction of Metal, commonly judged as a Draw.

Fig. 2.—Casting showing Porosity due to Trapped Gas by Reduced Speed of Metal Flow at Large Boss.

Fig. 5.—This is exactly the same as Fig. 4, but with a Riser to remove the Gas. The two results provide an interesting comparison, as the same metal was used in both cases.

Fig. 3.—Feeding Head showing Gas Porosity at Top and Shrinkage Porosity at Bottom, from which Metal has been drawn to feed the job below.

Fig. 6.—Shows Metal Shrinkage or True Draw in Thick Bosses.

the metal itself or from the shanks and ladles or from the actual swilling of the sand from the mould. Dirty metal is frequently found where the scrap used is unsuitable, where the fluxes used in the cupola are insufficient, or where the slagging of the cupola is not satisfactorily carried out. Even with good metal poured into a clean hot shank there will be a continual rise of small particles of slag and dirt as the metal cools, and it is frequently of great advantage in making small intricate castings to pour the metal from the large ladle into a shank

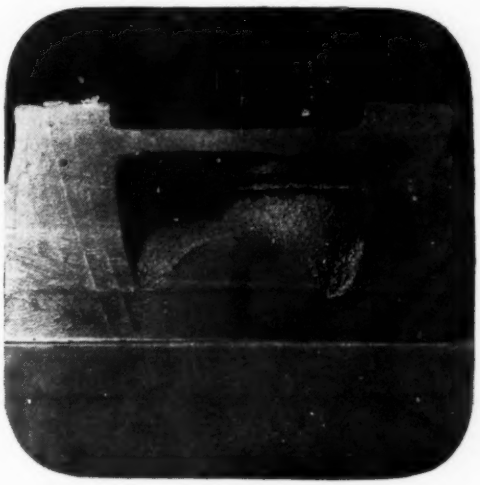


FIG. 7.—THIS IS THE SAME AS FIG. 6, BUT SHOWS THE INFLUENCE OF CHANGE TO CORRECT THE COMPOSITION OF THE METAL.

before casting, with a view to giving the metal an opportunity to get rid of some of the minor portions of slag.

Probably the greatest cause of loss in foundry work is due to blow holes owing to insufficient means of escape of the gases generated. In complex dry-sand moulds it is to be remembered that whilst the hygroscopic moisture has been removed in the drying stove there is still present the combined water of the binding agent in the sand. It is this moisture that the practical foundryman is liable to overlook in considering whether his mould

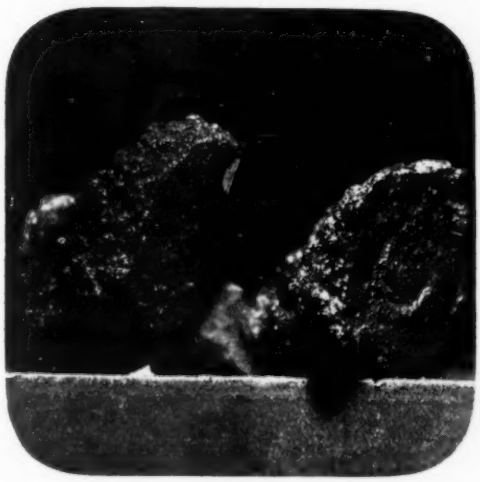


FIG. 8.—PORTION OF TWO THICK BOSSES. ONE CONTAINS ¾-IN. CHILL, BUT POROSITY IS STILL PRESENT, BEING DUE TO GAS.

is sufficiently dried, and the only way in which he can meet it is to see that his facing sand is sufficiently "open" to allow its escape and so remove the possibility of scabbing and blowing. Many of the difficulties associated with combined water in the moulding and core sands can be eliminated by the use of oil-sand cores, and further developments in the use of oil as a binder for moulding sands is to be expected in the near future.

Illustrations of the various types of porosity are given, which will repay careful study.

Summary.

Summarised, therefore, the means which are available for the prevention of porosity in castings are:—

(1) Correct mixtures of metals to suit the work and thus reduce the graphite porosity to a minimum.

(2) Correct melting of the metal and casting temperature so that the natural shrinkage of all parts is met by suitable graphite deposition and consequent expansion to fill the mould.

(3) Suitable feeding of thick portions of the metal by either rods or risers.

(4) The correct use of "chills" or denseners to bring about the quick setting of thick parts of the casting. This method should only be used as a last resource, as chills are a frequent cause of gas porosity.

(5) Efficient venting of the mould in the region of thick parts. Thus an air riser will frequently remove accumulations of gas on flat faces when the metal is moving rapidly towards the meeting place of a number of sections.

(6) Thorough working combination with the designers for the production of a design which whilst satisfying the requirements of the article to be produced shall also be a practical job for the foundryman.

In conclusion it may be said that there is no single cause or cure of porosity in castings. Each case has to be dealt with on first principles and moulding, feeding, chilling and metal all attended to.

Sand Conservation and Reclamation.

F. L. Wolf, Chairman of the A.F.A. sub-committee on Conservation and Reclamation of Foundry Sands, has submitted a progress report to the *A.F.A. Bulletin*. This reclamation investigation is being carried on at the plant of the Ohio Brass Company, under the supervision of the Joint Committee on Moulding Sand Research. The report, in part, states:—

"At present no waste sand from the brass foundry is being rejected. All waste sand is tested for bond, permeability, etc., and the sand reclaimed by the addition of Ohio sands of various kinds, which give the spent sand the properties which have been removed by use.

"The necessary additions are made in two ways: By the use of a Muller mixer, and by the use of a revolving belt mixer.

"During the month of January, 1924, the brass foundry reclaimed sand valued at $125.00 (£29). This foundry employs about 40 moulders and melts 40,000 lbs. (18 tons) of brass per day. The saving of sand alone paid for the time of one man who directed the reclamation and conservation work.

"The value received was not due to the sand saving alone, but to the fact that all of the sand heaps were kept under control. Losses due to misruns and dirty castings were reduced considerably and the effect upon the moulders cannot be estimated in dollars and cents.

"The moulders are very much interested, and personally insist that their heaps be checked regularly for bond, permeability and moisture.

"The malleable iron plant of the Ohio Brass Company has 72 floors and active work of conservation and reclamation is now being started in this foundry. No positive data has been secured as yet, but as soon as possible the results secured will be reported to the membership of the A.F.A."

In addition to the work being carried on at the plant of the Ohio Brass Company, an investigation is being conducted at the plant of the Hunt-Spiller Manufacturing Corporation, under the supervision of R. F. Harrington, a member of the committee.

Investigation is contemplated along the lines of washing old sand and reclaiming for use in cores.

J. H. WOOLLISCROFT & COMPANY, electrical and mechanical engineers, have removed from Queen's Buildings, New Quay, to King Edward Street, Liverpool.

The British Cast-Iron Research Association: Its Present Work and Future Development.*

By J. G. Pearce, B.Sc. (Eng.), M.Inst.Brit.F., M.I.E.E.

Introduction.

It is well known that the war revealed certain deficiencies in British manufacturing industries, due to the lack of utilisation of the most recent scientific advances, and to many observers this country prior to 1914 presented the curious paradox of an unequalled and brilliant record in pure science discovery, combined with an almost complete failure to secure ordered and systematic progress in industry by applying the new knowledge so revealed, and at the same time very considerable degree of fertility and resource in invention as distinct from discovery. The advantages which other countries, notably America and Germany, derived from the application of science, frequently of discoveries originating in this country, have repeatedly been laboured. No country in the world has any marked advantage over Great Britain in the genius and originality required in the production of new knowledge. Other countries exhibited, however, greater prescience in utilising new knowledge for the improvement of their materials, methods, and processes, and in applying scientific method to all parts of the manufacturing organisation. Science was too valuable a weapon to ignore. Realising that fundamental research is the inevitable precursor of its applications, the one being the foundation and the other the superstructure, they are now endeavouring, by lavish endowments, to create schools of research, to attract workers to take up research as a permanent vocation, and, in short, to do all that wisely administered funds can do in repairing deficiencies in fundamental discovery. Under the pressure of urgent necessity, steps have been taken in this country to bridge the gap between science in industry, and the means adopted are of considerable interest and significance, especially as they are novel and not found elsewhere. Before examining them the reasons for the pre-war failure to do so may be considered.

Research Developments in Great Britain.

The very variety of the world-wide demand for British goods encourages the comparatively small firm, which invariably lacks the resources required to conduct organised research, and this condition is accentuated by the British tendency towards individual working and lack of confidence in co-operative schemes. The most able scientific men found the university atmosphere more congenial than that of the works, and about many scientific workers there was an aloofness from industry which did not encourage manufacturers to seek scientific aid. Organised workers had apparently no opinion to offer regarding research in industry. The result was that the resources of manufacturers and the skill of work-people were not supported by the application of science. The improvement of existing industries with reference to materials and methods was largely fortuitous and unregulated. Certain new industries which were created through research flourished on the Continent, and some of these proved during the war to be so-called key industries, without which the industrial fabric would have soon ceased to exist. A further reason for the lack of contact between science and industry was failure of both sides to realise the enormous amount of work required in the application of science, with the result that many manufacturers thought their requirements fully provided for by a chemist or metallurgist already fully engaged on routine production problems.

The amount of technical work involved in rendering new knowledge serviceable to a particular industry is such that a new vocation has arisen, that of the industrial research worker, whose function in an industrial organisation is to ensure that his industry, through a properly organised research department, shall make fullest use of new developments. This work, however, is confined on the whole to the larger industrial concerns.

The concentration of industrial works into a group with single financial control facilitates the development of research work on a large scale. One of the features of British post-war industrial development has been the aggregation of manufacturers into groups, financially interlinked. These groups do not form trusts, or so-called horizontal combinations, as understood in the States, seeking to control the whole of the output of a particular industry, but so-called vertical combinations, forming a complete manufacturing chain in which the product of one works is the raw material of the works next in the chain. Such a group ensures its supply of raw materials at all times, and can obviously economise through unified manufacturing, selling and purchasing policies without risking the obvious evils of trustification. Among some of these larger groups research facilities have been provided on a generous scale, and investigations are being conducted comparable with those of the industrial groups in America and Germany. On the whole, however, British industry remains in the hands of manufacturing concerns limited in size and output, independent of other works except through some form of trade association for the purpose of dealing with problems of output, standardisation, and so on. Such works are unable to provide a staff of research men, and it is obviously undesirable that large numbers of small works should undertake research individually when their main technical problems are common to all, and when combined action in winning and maintaining export markets is so urgently required.

These conditions suggest the development of research on a co-operative basis. The cost of the work involved, together with the cost of determining what has been done and is being done elsewhere is minimised. The comparatively limited number of men available for research work is utilised to the best advantage.

The ironfounding industry exhibits a larger variety of concerns than any other. The number of foundries in Great Britain producing iron castings is approximately three thousand, spread throughout the whole country. Many of these are extremely small local jobbing shops, employing a mere handful of men, and not concerned with the production of castings to meet severe conditions. The remainder include large foundries of the most modern type, with the latest equipment, producing castings to stand severe working conditions, down to the small shop engaged entirely on speciality work. Some foundries are attached to engineering concerns, mechanical, electrical, marine, automobile, textile, making their own castings, while other foundries manufacture for the trade. The products include both grey iron and special iron castings, and malleable iron. Probably no country in the world has operatives which show the same degree of manual skill, or foremen and managers having the same degree of resource as British iron foundries, and these very qualities have resulted in a tendency to be independent of scientific knowledge.

The industry, however, is rapidly changing. The future line of development does not lie in a mere increase in the quantity of cast iron produced. For many years the output of pig-iron in Great Britain has been of the order of ten million tons per annum. The future lies rather with the improvement of cast iron to meet special service requirements. The development of the great automobile, heavy oil-engine, aeroplane, electrical, and other industries has resulted in a demand for many materials of a very high quality. Cast iron, by virtue of its cheapness and ease of production, has been a Cinderella among materials. It has been utilised naturally in the initial stages of development of a wide range of industries, and discarded in favour of other materials as the standard of performance increased and demand become more severe. The business of the foundry industry is to secure such knowledge of the constitution, proper-

* A Paper read before the Empire Mining and Metallurgical Congress.

ties, and modes of manufacture of cast iron that the material can be utilised as fully as its inherent possibilities and its cheapness permit.

Illustrations of the value of research are quite close to hand. The extraordinary development of the steel industry through research is a case in point, and the non-ferrous metals industries are now adopting the research method with enthusiasm. The astonishing position secured by the malleable iron industry in America is another instance of the prestige which a material can secure when backed by consistent search for improvement.

The Research Association Movement.

In 1915 the deficiencies in the supply of war material, due to the shortage of trained research workers and the lack of application of science in industry, were so pronounced that a special Committee of the Privy Council was appointed by an Order in Council to consider the whole question of research in its relation to industry, the terms of reference covering the training of research men, the aiding of existing researches, and the encouragement of the necessary liaison between science and industry. This Committee was assisted by an Advisory Council of scientific men, principally drawn from the Royal Society. The Advisory Council is permanent, although, of course, its personnel changes.

To co-ordinate the work involved, and to supervise the expenditure of funds, a small permanent Department of Scientific and Industrial Research was created. Parliament, on the recommendations of the Advisory Council, voted the sum of one million sterling to promote the ends in view, the money and other property being held by the Imperial Trust for the Encouragement of Scientific and Industrial Research, a body comprising seven Cabinet Ministers acting by Royal Charter.

In making its recommendations with regard to the creation of research institutions in industry, the Advisory Council found that the most promising advance would be secured if industries themselves undertook the research necessary for their continued existence and expansion. The scheme finally recommended was that under which a voluntary association of manufacturers in an industry, either existing or created for the purpose, undertakes the conduct of research work. To encourage industries it was arranged that annual subscriptions from such groups of manufacturers over a certain absolute minimum, and under a certain desirable minimum, should be doubled from the Imperial Trust Fund for a minimum period of five years. In special cases where a key industry was involved a higher subsidy was to be paid. In the case of the Cast Iron Research Association the absolute minimum is £2,500, and the desirable minimum is £5,000.

An interesting feature of the whole scheme is the ingenuity with which advantage was taken of our elastic constitution to have this work carried on without being subjected to the vicissitudes of political life. The responsible Minister (the Lord President of the Privy Council), who is in close touch with all parts of the Empire, but who has few administrative responsibilities, and the Committee of the Privy Council form the constitutional machinery. The Advisory Council consists of scientific experts, and its recommendations are normally accepted by the Committee of the Privy Council. For the first time scientific men were provided, through the scheme, with an opportunity of planning a broad and national research policy. The Research Associations, which are virtually limited companies not paying dividends, are essentially British, no foreign corporations or corporations in the Empire under foreign control being admitted as members. The results of investigations are confidential to members.

It would be unprofitable to discuss in general terms the nature of the work of a Research Association, of which some two dozen have been formed. Industries differ widely both in character and history. The electrical, automobile, and aeroplane industries referred to above have achieved an astonishing state of development in a very short time, almost entirely upon a basis of academic and applied research. No member of these industries requires to be convinced of the value of research. It is impossible for them to proceed without it. Other industries—agriculture, textiles, tanning, etc.—have been practised for centuries, and until comparatively recent years have been almost entirely unaffected by organised research. The main source of progress has been the improvement in the skill of operatives, increase in the experience and empirical knowledge of managers and foremen, and the occasional introduction of an invention sometimes of an epoch-making character. To the latter group ironfounding belongs. The enormous developments in metallurgical studies have been applied principally to steel and non-ferrous metals, but little change has been made in the traditional procedure of production of grey iron and malleable iron castings.

The ironfounding industry, therefore, requires in the first place pioneer research in the constitution and properties of cast iron, and large-scale investigations in its methods of production and treatment. The pioneer work may be undertaken by the Research Association, or by university and national laboratories; but the work on processes of manufacture and treatment can only be done by the Research Association, which has access to large-scale plant and industrial experience. Furthermore, the Research Association will have to enable members to apply this and other scientific knowledge to particular problems in ironfounding, and so secure advances in the quality and uniformity of the material and the ease with which it is produced. An extensive programme of industrial research work may also involve empirical attacks on urgent problem where knowledge is inadequate to provide a proper basis for research.

Research results must be applied with reasonable speed in the industry, and this requires in many cases educational work among managers and operatives. The Research Association can, in a very real sense, act as a liaison between manufacturing concerns in the industry on one hand, and the universities and national laboratories on the other. It may protect its members against unreasonable demands on the part of consumers through specifications, and it can aid its members in enabling desirable specifications to be met. It can play a considerable part in the development, within the industry, of standards of material and tests, and thus pave the way for national and, ultimately, international standards. It can do a considerable amount of work in promoting a high standard of education in the industry.

Developments occasionally take place in the industry, such as, for example, the introduction of "semi-steel," and more recently of the so-called pearlitic cast iron, the possibilities of which require to be considered by a properly constituted body for the whole industry, otherwise applications are likely to be casual, irregular, and confined to few foundries. Inadequate examination in such cases may frequently lead to disappointing results.

The Cast Iron Research Association.

The British Cast Iron Research Association is one of the most recently formed of these bodies, being incorporated in June, 1921. At this time the post-war boom in trade was still operating, but the slump conditions were beginning to reveal themselves. No one could have foreseen the acuteness and length of the trade depression, which was felt with particular intensity in the foundry industry. This adversely affected the Association in two ways: it naturally deterred prospective members from joining, and reduced the income from existing members, because the subscription is based on the actual amount of labour employed in the foundry, which diminishes in times of bad trade. At the present time the outlook shows distinct signs of improvement.

The Association was fortunate in obtaining as its first President Lord Weir of Eastwood, the well-known managing director of G. & J. Weir, Limited, of Glasgow, and the Vice-Presidents consist of a group of distinguished industrial leaders and metallurgists.

The Council is elected annually, and is representative not merely of the various interests of the Association with regard to variety and character of product, but of each foundry district in the country, which is divided for this purpose into sixteen areas. The Council itself is strengthened by members nominated by the Department of Scientific and Industrial Research, and among members of the Association are delegates elected

by the leading technical and scientific institutions. Much of the internal work of the Association is conducted by Committees elected by the Council, the chief of which, the Research Committee, has sub-committees for each important line of work in progress.

The member-firms include grey iron and malleable ironfounders, and engineers in the mechanical, electrical, textile, marine, automobile, and other industries. Users of cast iron who are not founders are also accepted as members. A small rebate is allowed on subscription rates for unskilled men, so that firms employing large numbers of unskilled moulders on repetition work are not unduly penalised. In the case of blast-furnace proprietors the subscription is based upon the tonnage of foundry pig produced per annum. Where members have a foundry as part of their business the subscription is based on that part of the business actually employed in the production of iron castings.

Technical Information Bureau.

An important feature of the Association is the Technical Bureau, through which any member of the Association can obtain information on any aspect of foundry practice. The Association receives a large number of books, technical periodicals, and papers in various languages, and is in close contact with other technical libraries in various parts of the country.

Apart from answering specific inquiries, the Technical Bureau is able to keep the Association's investigators and members advised of advances in any subject in which they are specially interested, and where a matter is of general interest to members bibliographies and reports for publication in the Bulletin are prepared.

Careful surveys are made from world-wide sources of information when a new investigation is contemplated, to ensure absence of overlapping and the fullest use of existing knowledge.

Publications.

The publications of the Association are of two kinds. Research reports are issued as and when complete, and are invariably printed. These reports are strictly confidential to members, and may not be divulged to others, or published, without the express permission of the Council. A quarterly Bulletin is issued, which acts as a means of personal contact between the officers of the Association and members. This Bulletin briefly records the activities of the Council and Committees, and deals with advances in foundry work and practice from all sources. Abstracts of significant articles appearing in the technical press are also given. The Bulletin is circulated to members, and to certain selected university and other libraries.

The following investigations are actually in progress at the present time:—

Fundamental Properties of Cast Iron.

This investigation is being conducted in the Metallurgical Department of the University of Sheffield, under the supervision of Professor C. H. Desch, F.R.S. It was initiated for the purpose of elucidating causes of defects arising through shrinkage and draws in foundry castings. A form of casting was designed to show these defects in a maximum degree, and the castings were made under controlled conditions at the works of certain members. These castings have provided test-pieces for the conduct of a wide range of mechanical, physical, chemical, microscopic, and magnetic tests. Careful investigation has shown over a score of direct causes of shrinkage and draw defects in castings, about 70 per cent. of which are associated with foundry technique—that is, with moulding, gating, pouring, and melting processes. The remainder are connected with the constitution and treatment of the metal itself. The effect of the usual elements in cast iron on shrinkage is to be studied in a series of irons covering such variations in silicon, manganese, phosphorus, and sulphur as are normally found in ordinary practice.

Automobile Cylinder and Piston Castings.

This investigation was initiated by a Joint Committee of the British Cast Iron Research Association, the Research Association of the British Motor and Allied Manufacturers, and the British Motor Cycle and Cycle Car Research Association. Considerable work has been done on cylinder irons, and at the present time the influence of heat upon the expansion and permanent distortion of automobile pistons, up to and including temperatures of 800 deg. C., is being investigated at the University of Birmingham, under the supervision of Professor T. Turner.

Moulding Sands.

Considerable laboratory research has been done in this country upon moulding sands, notably by Professor P. G. H. Boswell. An investigation is now in progress in the works of the British Thomson-Houston Company, Rugby, under the supervision of Mr. W. B. Parker, F.I.C., chief chemist. This will give detailed information upon the resistance to erosion by molten metal, gas permeability, heat conductivity, and other properties of British moulding sands and sand mixtures on a practical foundry scale, together with methods by which spent moulding sands may be most effectually and economically reclaimed.

Cast Irons to Resist High Temperatures.

The manufacture of glass bottles demands exceptional heat-resisting properties in the mould, and a Joint Committee was set up by the British Cast Iron Research Association and the Glass Research Association for the purpose of solving difficulties arising in this connection.

The Glass Research Association is now testing commercially the use of moulds which have been prepared from mixtures resulting from this investigation. Irons developed for such service can obviously be utilised for other high-temperature applications, and investigations are proceeding in applying heat-resisting irons in other directions.

Standard Test Specifications.

The Association is co-operating with the Institute of British Foundrymen and the British Engineering Standards Association in the development of a standard test-bar and an accompanying specification. The industry will obviously benefit by the adoption of such standards, which will in due course become international.

Graphitisation of Cast Iron.

The Association is co-operating in a research being conducted, under the supervision of Professor F. C. Thompson, at the University of Manchester, on graphitisation in cast iron. Through the synthetic preparation of a white iron it is possible to study the production of graphite without the uncertainty arising from the presence of the many variables in ordinary cast iron. The investigation will throw much needed light upon the character and time of graphite formation.

Corrosion-Resisting Cast Irons.

An extremely important investigation has been commenced for the Association at the University of Sheffield by Professor C. H. Desch, F.R.S., on a series of irons to resist various types of corrosion. Irons are being made in a cupola completely under the control of the investigator and also under ordinary commercial conditions and subjected to a range of tests. The object is to determine mixtures which will afford greatly increased resistance to corrosion compared with ordinary grey iron and yet capable of being produced in the cupola and machined in the machine-shop. The completely non-corrodible iron silicides (15 per cent. silicon) are difficult to produce and practically impossible to machine.

Influence of Nickel and Chromium on the Graphitisation of Iron.

The Association is co-operating in the conduct of a research, under the supervision of Professor T. Turner, of Birmingham, on the influence of nickel and chromium on the graphitisation of iron. This investigation is of particular interest to malleable iron manufacturers, and aims at determining the influence of small quantities of nickel and chromium, separately and in combination, on the mechanical properties and annealing time.

Electrical and Magnetic Properties of Cast Iron.

An investigation of the electrical and magnetic properties of ordinary irons and of special mixtures is being conducted at the University of Birmingham under the supervision of Professor T. Turner. This is of great interest to those concerned with the production of irons of special and uniform magnetic or electrical qualities.

A formal list of investigations (each of which is being conducted by a trained investigator) cannot, of course, cover all work in progress. For example, an important report is in preparation on British cupola practice, to enable members to standardise on practice which gives the best results.

RESEARCH POLICY.

The field of research open to the Association may be broadly indicated to show what work requires to be done.

Fundamental Metallurgical Research upon Cast Iron, Malleable Iron and Toughened Cast Iron (Semi-Steel).

The aim of this research is general rather than specific, and intended to increase knowledge of the materials themselves. It covers a complete study of the alloys comprised within the iron-carbon equilibrium diagram, and their chemical and physical properties and structure. It seeks to determine the modifications of that diagram brought about by the presence of silicon, manganese, sulphur, phosphorus, copper, nickel, chromium, titanium, vanadium, tungsten, molybdenum, either separately or conjointly in the presence of carbon; the influence of the foregoing elements when alloyed separately or conjointly with carbon and iron in cast irons on shrinkage and contraction, porosity, viscosity, density, and surface tension, and on the presence of gaseous inclusions, graphitisation, and growth or expansion under repeated or prolonged heating conditions. Ultimately such research should facilitate complete correlation of chemical composition and mechanical properties at all temperatures.

The Production, Remelting, and After Treatment of Cast Iron.

This field broadly covers blast furnace and cupola practice and other methods used for the production of synthetic pig-iron or for the remelting of cast iron, as in electrically or otherwise fired open-hearth, rotary-kiln type, or crucible furnace. Here is presented a field in which but little work has been done, and one likely to yield results of immediate practical interest to the foundryman.

In cupola melting, for example, is included the influence of design, tuyere proportions, blast pressure, volume, and velocity upon the melting capacity and quality of product; the charging of metal and fuel and the fluxing of ash and oxidation products; the methods required to overcome lining wear and to facilitate desulphurisation of the metal; the regulation of combustion and means for obtaining uniformly regular melting without oxidation of the metal.

In blast furnace practice the area covered is similar in character to the above, the aim being the determination of the conditions of fusion temperature, speed of smelting, control of fluxing slags, and of metal carburisation and alloying, whereby cast iron of uniformly good character can be secured.

This section also covers the preparation of the mould, whether in loam, green-sand, or dry-sand; the use of metal or permanent moulds; machine moulding; the problems associated with pouring castings; speed of teeming and size and disposition of runners, gits, and rising heads; the influence of gating-pressure head and lift of moulds; function of chills and denseners; the venting of moulds and cores and the relieving of strain; the effect of design on the strength of cast iron in cored and ribbed castings, influence of mass on time of solidification and cooling and on the rate of contraction; the avoidance of hard spots, fins, distortion, and warping; the reheating and annealing of grey iron and malleable castings.

Investigations on Auxiliary Materials used in Foundry Practice.

These cover moulding sands, facings, and washes, including gas permeability, heat conductivity, and erosion resistance of sands and sand mixtures; sand reclamation; synthetic sands and bonds for medium, light, and heavy castings; core sands, facing sands, and blackings, composition, preparation, sources of supply and standardisation; refractories for cupola and ladle linings, including lining erosion; fuels, chemical and physical properties of coke suitable for foundry practice; slags and fluxes; the balancing of slag constituents; the absorption by slags of oxidised iron, silicon, and manganese.

The Development of Particular Irons to meet Particular Specifications and Classes of Service.

Considerable developments are likely to take place in this field, and advances will be due, partly to scientific research, and partly to empirical methods of attack. Some illustrations of improvements required are as follows:—Irons to resist high temperatures, such as superheated steam; irons for die-casting and ingot moulds, for automobile cylinders and pistons and Diesel cylinders and pistons; non-corrosive irons to resist sea-water and air, acids, gases, etc.; non-erosive irons to resist mechanical erosion of fluids; irons of special electrical resistance and magnetic permeability; irons to resist abrasive wear; irons of low porosity to resist hydraulic pressures and gas pressures; irons having high mechanical strength at ordinary and elevated temperatures, and high resistance to alternating stress and fatigue.

The Standardisation of Materials, Tests and Specifications.

This includes classification and grading of pig-iron, and the standardisation of pig by physical and chemical analysis; specifications for various grades of grey iron, malleable iron, and toughened cast iron (semi-steel); specifications for sands, refractories, fuels, fluxes; standardisation of test-pieces, methods of testing and sampling, and the correlation of methods of testing, chemical, mechanical, thermal, and microscopical.

Study of Failures.

It is a truism that education in the engineering and metallurgical industries largely proceeds by failure, in so far as experience is derived from practice. In common with other Research Associations, the Cast Iron Research Association finds considerable assistance in the study of failures and difficulties reported by members. Such work with members enables the Association to keep in direct and close contact with the industry and with its most pressing problems, and this information is invaluable in determining the research programme.

The Association has the assistance, as consultant, of Mr. J. E. Fletcher, M.I.Mech.E., who, whilst attending particularly to the technical side of research, assists members who may be in special difficulty, or who need advice in tackling new problems. Mr. Fletcher's unique foundry and metallurgical experience is of the greatest possible assistance.

The precise researches undertaken by the Association obviously depend in a large measure upon its financial resources, and upon the needs and requirements of members. The Research Committee endeavours to maintain an adequate balance between all the sections of research referred to above, and various interests in the Association.

The Association also maintains close touch with research institutions, such as the National Physical Laboratory and the various university laboratories, in addition to the British Engineering Standards Association, the Imperial Mineral Resources Bureau, and the technical and scientific institutions, particularly the Institute of British Foundrymen.

As an illustration of its value in promoting the welfare of the industry as a whole, the success of the first International Foundry Trades Exhibition, held in Birmingham in 1922, may be quoted. The Association actively co-operated with the promoters in providing the necessary technical advice.

XUM

The Effect of Casting Temperature on the Physical Properties of a Sand-cast Zinc-Bronze.*

By Francis W. Rowe, B.Sc., Member (Manchester).

The object of this investigation was to determine, for works use, the optimum casting temperature to give the required mechanical properties in a gun-metal of the composition specified. The author realises that the results would have been more valuable had they been extended to cover the effect of variations in mass and other methods of casting and moulding.

The alloy used is one which gives very satisfactory service for castings which must have good strength and toughness, and is one which is easy to handle in the foundry. The nominal composition is: Copper, 88: tin, 6; and zinc, 6 per cent.

In practice a lead content with a maximum of 1 per cent. is permitted, and a maximum variation of tin and zinc contents of 0.75 per cent. either way. The alloy is usually made up of ⅓ virgin mixture (88: 6: 6), ⅓ remelted borings of same alloy (with corrections), and ⅓ heads and runners of same alloy.

The ingot copper, ingoted borings, heads and runners are melted under charcoal, and the tin and zinc added after the pot is withdrawn from the fire at a temperature of 1,250 deg. C. to 1,275 deg. C.

The author has several times made freezing-point determinations of different samples of this alloy and found that the primary solidification begins at 1,005 deg. C.

Method of Making the Test Bars.

Six boxes of test-bars were moulded. Each box contained two 14 × ⅞ in. dia. bars moulded horizontally in green sand. Each box (*i.e.* two bars) was run with a down runner 1¼ in. diam, terminating in a splay to both bars. The splay fed both bars at the end at practically the full diameter. The riser was exactly similar to the runner. Fig. 1 shows a sketch of the finished test-bars.

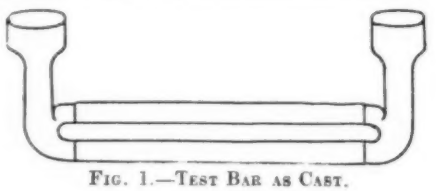


FIG. 1.—TEST BAR AS CAST.

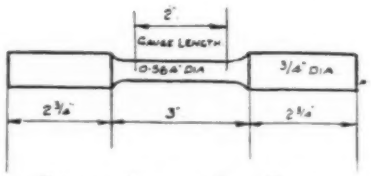


FIG. 2.—TENSILE TEST BAR.

One hundred and twenty lbs. of the alloy (made from scrap and virgin metal) was melted in a forced-draught pit furnace in a 150-lb. Morgan Salamander crucible. The metal was in the fire sixty-three minutes. After drawing the pot the necessary tin and zinc were added and the boxes cast. The temperature of the metal prior to pouring each box was taken with a Foster base-metal bare thermocouple, previously calibrated against a standard platinum—platinum-rhodium couple and found accurate to 2 deg. C. over the range used.

The boxes were cast at the following temperatures:—No. 1, 1,210; No. 2, 1,170; No. 3, 1,130; No. 4, 1,090; No. 5, 1,050; and No. 6, 1,020 deg. C.

In the case of the last box to be poured, the metal was too stiff to fill more than half the riser —i.e., the solidification of the castings had taken place before sufficient metal had flowed through to fill the riser.

* A Paper read before the Spring Meeting of the Institute of Metals, slightly abridged.

It was noticed that the runner heads on those boxes cast at the highest and lowest temperatures were quite flat, but those cast at intermediate temperatures were slightly sunken.

Analysis of Test Bars.

Two analyses were made, one on drillings from the bottom of the runner of No. 1 bars, and the other on drillings from the riser from No. 5 bars. As these two analyses only differed within the limits of analytical errors the average can be taken as:—Copper, 87.96; tin, 6.08; lead, 0.52; zinc, 5.31; iron, 0.02; and phosphorus, 0.021 per cent.

No estimations of arsenic and antimony were made, as the foundry uses only "Lamb and Flag" tin, and the highest grades of "best-selected" copper, and previous determinations have shown these elements to be present only in negligible quantities.

Physical Properties of the Bars.

Each bar was divided into three pieces—an 8½ in. length from the end for tensile tests, a 5½ in. length from the other end for Izod impact and hardness tests, and a ½ in. piece from the centre for microscopic examination. The tensile test-piece was machined as shown in Fig. 2. The Izod test-piece was the B.E.S.A. standard 10 mm. sq. bar with three notches. The yield-point was taken with a pair of dividers in the usual workshop manner, and so no great value can be attached to those figures. Hardness tests were made with a Brinell machine using a 10-mm. ball and 500 kg. load on the Izod pieces after breaking. The Izod figures were obtained on the 120 ft.-lb. Avery Izod machine. The results are tabulated in Table I:—

TABLE I.—*Mechanical properties of sand-cast zinc-bronze.*

No.	Casting temperature °C.	Yield point, per sq. in.	Max. Load, Tons per sq. in.	Elongation on 2 in. per cent.	Izod Impact ft.-lb. average	Brinell hardness No.
1	1210	7.9	17.3	37	13.8	51.8
1A	1210	7.8	16.9	35	13.6	50.3
2	1170	8.0	17.4	39	21.8	54.3
2A	1170	8.1	17.3	38	20.7	56.0
3	1130	8.2	18.4	50	23.3	57.7
3A	1130	8.2	18.7	51	28.0	58.6
4	1090	8.1	14.5	18	18.0	60.5
4A	1090	8.2	15.6	23	18.0	59.6
5	1050	8.0	11.0	6	16.2	61.5
5A	1050	8.1	13.4	10	15.8	60.5
6	1020	8.2	10.2	4	17.0	62.5
6A	1020	—	Badly blown.	—	16.9	63.6

The averages of the two results for each bar are shown graphically in Figs. 3 and 4. The fractures of the bars Nos. 1 to 3 showed a close crystalline structure. Nos. 4 to 6 showed a rather coarse

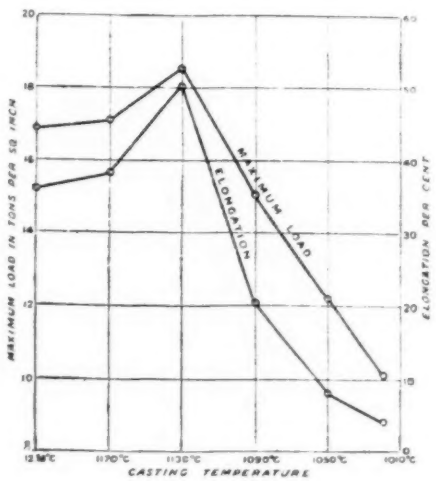


FIG. 3.—INFLUENCE OF CASTING TEMPERATURE ON THE MECHANICAL PROPERTIES OF SAND-CAST ZINC-BRONZE.

granular structure with white specks. The tensile test-piece from bar No. 6A, was too badly blown to test. This is common with green-sand castings

cast at a very low temperature. Any local dampness of the mould causes the metal to blow, and it has set before it recovers itself.

CONCLUSION.

It is obvious that the casting temperature exerts a very marked influence on the physical properties of the alloy. The optimum temperature is very clearly marked in this series of tests. The yield-point shows no appreciable variation. The Brinell hardness figure rises continuously with the fall in casting temperature, which is a feature

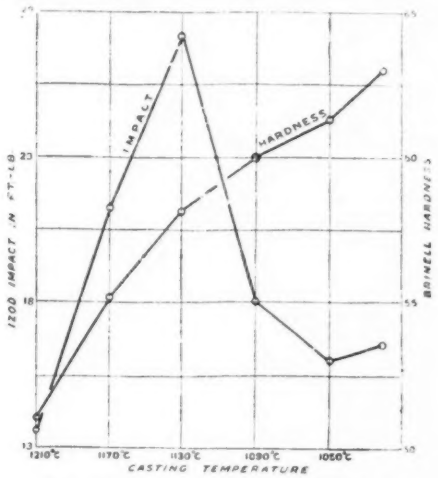
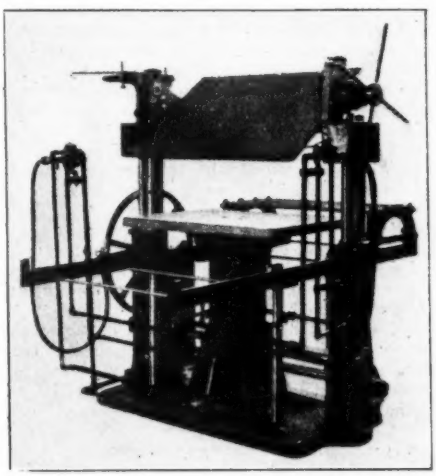


FIG. 4.—INFLUENCE OF CASTING TEMPERATURE ON HARDNESS AND IMPACT FIGURES.

common to all classes of gun-metals and bronzes. It is quite probable that different sizes of test-bars might give appreciably different results, as also might dry sand-moulds. Therefore this optimum casting temperature is probably only applicable to castings of a similar section and moulded in a similar manner.

The Peacolt Moulding Machine.

Although foundry practice in this country has of late years made rapid strides, and in many respects has reached a high level of efficiency, there are certain directions in which there is still scope for improvement. It is a fact, for example,



THE PEACOLT PNEUMATIC MOULDING MACHINE.

that numerous foundry managers have not yet realised the possibilities of machine moulding as a means of increasing output and reducing costs.

In these days of keen competition and heavy overhead charges it is more than ever necessary to adopt every possible means to put foundries on a sound paying basis, and, other things being equal, the machine-equipped foundry has a decisive advantage over establishments lacking up-to-date apparatus.

The advent of improved appliances, therefore, has a particlar interest for our readers, and for the benefit of those who are not yet acquainted with the new-type "Peacolt" pneumatic moulding machine—which has recently been put on the market by the Pneumatic Engineering Appliances Company, Limited, of 14, New Burlington Street, London, W.1—we append a few details about this latest development in British foundry engineering.

The machine is of the jar-ramming turnover type, and, by removal of the turnover table and substitution of lifting forks, which can be effected in a few minutes, is readily converted to stripping-plate operation. The advantages of a dual-purpose machine of this kind are apparent, but even more interesting from a technical and practical standpoint is the system of oil-controlled pattern-drawing embodied in the Improved "Peacolt."

The problem of designing an air-operated machine, capable of drawing deep and difficult patterns without a break-away of the sand, is one that hitherto has rarely been satisfactorily solved. Compressed air is a highly elastic medium, and to regulate it in such manner as to provide an absolutely smooth and steady movement of the pattern-drawing mechanism—subject, as the latter is, to varying stresses and resistances—has proved a practical impossibility.

The designers of the improved "Peacolt," however, recognising that satisfactory pattern-drawing is vital to the success of machine moulding, have now overcome this difficulty in a very ingenious manner. Air pressure is admitted to an oil tank enclosed in the body of the machine, and the oil is forced through a special combined oil and air cock to the bottom of the lifting cylinders. Oil being virtually incompressible, the rate of flow through the cock can be controlled to a nicety, and irregular movement of the pattern-drawing mechanism is thus completely eliminated.

It is possible to control the pattern-draw with such accuracy that—like that of the hand of a clock—the movement is almost imperceptible. As soon as the pattern is free, of course, the lift is speeded-up for the remainder of the draw, which is completed without a sign of jerk or vibration.

If the makers' claims for this system of oil-control are borne out, the machine marks a distinct advance in moulding practice, which should especially appeal to foundrymen whose criticism of machine moulding has been levelled—not without some justification—at inefficient pattern-drawing.

The "Peacolt" machine presents several other novel and practical features. We understand that this machine is being successfully employed by railway-group foundries and leading private concerns for the rapid production of R.C.H. standard axle boxes, and those familiar with the job will appreciate all that this fact implies.

Canadian Steelworks.—A Reuter's cable states that the steelworks of the British Empire Steel Corporation at Sydney, with the exception of one blast furnace and one battery of coke ovens, will close down on July 19 for three months.

Effect of Zirconium on Hot-Rolling.—In a Paper on the "Effect of Zirconium on the Hot rolling Properties of High-sulphur Steels and Occurrence of Zirconium Sulphide," read before the recent meeting of the American Iron and Steel Institute, at New York, Mr. Alexander L. Feild points out that zirconium eliminates red shortness when present in the finished steel in the proportion of 1.41 parts or more of zirconium to 1 part of sulphur; the ratio 1.41 corresponds to the formation of the normal zirconium sulphide, ZrS_2. Zirconium sulphide, like manganese sulphide, is plastic at rolling temperatures and, in polished sections, is visible as ovoid or elongated grey inclusions. Zirconium, unlike manganese, is not required in the finished steel in amount greater than that theoretically required for formation of zirconium sulphide, because of its powerful deoxidising action. In amount greater than that required to form the sulphide, zirconium confers on the sulphur content of the steel the property of insolubility in 1 : 1 hydrochloric acid, the percentage of sulphur thus rendered insoluble being proportional to the excess of zirconium in the ratio of 1 part of sulphur to 10 of zirconium.

A Note on Non-Metallic Inclusions in Metals, with Special Reference to Aluminium.*

By A. G. Lobley.

[*Abridged.*]

The importance of inclusions differs very greatly, not only because the effect itself varies with the nature of the metal and the importance with the application, but also on account of the very great variation in the facility with which the inclusions may be prevented or removed.

The subject, so far as steel is concerned, has been very clearly handled by McCance,† who, after referring to the very high percentage of failures due to this cause alone, by applying Stokes' law showed the probable velocity with which such particles would rise to the surface, and concluded from the figures thus obtained that it was improbable that particles smaller than 0.01 mm. in diameter would succeed in reaching the surface of the metal.

Aluminium oxide and most other insoluble impurities have a higher density than the metal itself and may be presumed therefore to have no tendency to rise; thus, while 2.70 may be taken as the density of aluminium, that of alumina may range from 3.5 to nearly 4.0 (according to temperature of calcination and similar conditions). Before any idea can be formed as to the possibility or otherwise of the inclusions being removed or prevented, it will be necessary to consider the origin of the oxide or other non-metallic substance which may be present as an inclusion.

It is exceedingly probable that aluminium which has been melted in contact with air does contain oxide, but it is difficult to imagine that metal which has been run straight out of an electrolytic reduction furnace (where it has been a cathode under a layer of cryolite) could contain anything more than a negligible quantity of oxygen.

With true virgin aluminium the only non-metallic inclusions to be expected are those of the electrolyte (cryolite with or without alumina in solution); and some refining action takes place on remelting. There was no positive evidence in the early days that any such refining action was necessary or even that it took place.

Cryolite present in Aluminium.

That some cryolite probably is held by the metal for a time would appear from the following observations:—

(1) Metal cast into rolling-mill billets direct from the reduction furnaces, when rolled into sheet and annealed, usually shows a species of small spill which is absent in metal that has been remelted or merely kept in a molten condition for one or two hours; (2) metal freshly tapped from the reduction furnaces is quickly covered by a film which, on being removed, is more rapidly replaced than it would be if it were only due to the usual action of the air; (3) the appearance of this film is quite different from that obtained when remelted metal is exposed to air under similar temperature conditions; (4) the micro-structure of freshly tapped metal reveals the presence of some substance evenly distributed along the crystal boundaries (and possibly between the axes of the dendritic structure), having a somewhat different appearance from that of the oxide, which, when present, is usually unevenly segregated.

Even if the cryolite existed in a form which had a lower density it is more than probable that the difference, taken together with the extremely small size of the particles (assuming its presence in the solid state in molten aluminium), would be quite insufficient to cause a rising movement rapid enough to bring about the removal of an appreciable amount by such gravitational means.

On the other hand, it appears to the author that if the assumption be made that cryolite is slightly soluble in aluminium, it is conceivable that some explanation might be forthcoming on the basis of diffusion from the interior to the surface from whence cryolite might be continually removed, either by volatilisation, or by an oxide surface layer taking up the cryolite, or by a combination of both. (Cryolite is distinctly volatile near its melting-point.)

In large-scale operations the remelting is usually carried out in a reverberatory furnace, consequently there is every opportunity for the metal to be acted upon by the gases, especially when scrap is being melted. Thus the elimination of the electrolyte is accompanied by a reaction which leaves still more harmful impurities in the metal.

Nitrogen, Carbon and Aluminium.

Nitridation as well as oxidation results from contact with air; a smell of ammonia being readily detected when skimmings are moistened. Whether any nitride, AlN, passes into the metal with the oxide is not at present known.

In the reverberatory furnace there is not only air, but also of products of combustion adding a rapid stream over the surface of the metal of further probabilities of contamination. What the nature of such contamination is does not yet appear to be known, but possibly the formation of the carbide, Al_4C_3, may play a part in the effects observed.

Electric remelting not harmful.

The detrimental effects of remelting can be very greatly minimised, if not entirely eliminated, by carrying out the operation in a suitable type of electric furnace. The author designed a resistance furnace for this purpose which resulted in a great improvement in the quality of the metal, it being possible to remelt even scrap and get high-quality sheet from the product; a procedure which certainly was not practicable with the reverberatory furnace. The author has always found zinc chloride to be the most effective flux. The object of the flux is to dissolve the thin oxide layer which prevents the globules of metal from coalescing.

Once oxide has got into the aluminium there does not appear to be any way of removing it. Owing to the small difference between the density of the metal and of the oxide gravitational separation is hardly possible. However, it might be thought that if the metal were covered with a suitable solvent flux and stirred, the oxide would be removed: there appears to be no data regarding this refining action, but if it takes place it is probably a very slow one.

With reference to the difference between true virgin aluminium and metal remelted in the reverberatory furnace, it is an interesting fact that experienced men can detect a difference in the flow of the metal; at the same time the difference between virgin aluminium and that electrically remelted is not so apparent.

The presence of non-metallic inclusions in aluminium is of considerable importance, but the subject does not appear to have received the attention it deserves. There is little doubt that oxide, when present in appreciable amount, reduces the ductility as well as having some effect on other mechanical properties. What the effect is of the small quantity of oxide in the best commercial metal is unknown, since there is no data regarding the properties of aluminium completely free from any kind of inclusion, if indeed such metal has been prepared.

If the effect of small amounts of non-metallic substances is very appreciable, then the subject is also of interest in its influence on data regarding aluminium alloys, the oxide content of which may be a very variable quantity.

A FURTHER MEETING of the creditors of Gwynnes Engineering Company, Limited, has been held in London to consider the position of affairs. Mr. S. Begbie, of the Aster Engineering Company, a member of the committee of creditors, presided. The chairman stated that a meeting had taken place with a financial house which was willing to help. The committee were still negotiating, and he asked the creditors for a little further time in order that the matter might be carried through. A resolution was passed authorising the committee to continue its negotiations.

---

* Paper read at the recent symposium on Slags and Fluxes, arranged by the Faraday Society, the Institute of Metals, the Institute of British Foundrymen, and the Non-Ferrous Research Association.

† McCance, *J. Iron & Steel Inst.*, 97 (1918), 239.

Patternshop Belts.

By James Edgar.

Patternshop belts are not always given the consideration they deserve. It is often erroneously thought that woodworking machinery belts do not require the same attention as the belts that transmit power to metal working planers, milling machines, and lathes. Neither the chain drive, laminated gearing, the direct drive from electric motor, nor rubber belt has displaced the ordinary leather belt, nor are they likely to do so in the immediate future. A good leather-belt service is hard to improve upon. The whole subject of belts is extremely important, and it is with the hope of concentrating the attention of foremen patternmakers on the subject that this article has been written. The writer has given a good deal of thought to the subject, and he is also indebted to many writers, American as well as British, who have studied the subject.

Principles.

The power transmitted by driving belts is proportional to the product of the effective tension in the belt and the running speed of the latter. Above a certain speed the horse power which can be transmitted decreases with increase of speed, owing to the effect of centrifugal force in reducing the permissible driving tension. Naturally, it is uneconomical to operate at speeds beyond the limit at which this effect becomes apparent.

With leather belts the speed beyond which power transmission begins to be reduced by centrifugal force is usually in the neighbourhood of 4,500 to 5,000 ft. per min., and is unaffected by the coefficient of friction between the belt and the pulley and by the angle of lap of the belt. The effective driving tension, on the other hand, depends essentially upon both the coefficient of friction and the angle of lap.

There has been much controversy on the subject of tension. Tension causes a belt to stretch, and it is partly elastic and partly inelastic. Several factors have to be taken into consideration, the ultimate strength of material, for instance, the stretch under a given load, and also the effect of centrifugal force. The effect during tension is the difference between the tensions in the tight and slack sides of a belt and, for a given value of this difference, the actual tension may have an indefinite number of values. With regard to centrifugal force, it has been laid down by experts that it acts on every particle of leather that is moving in a curved path, as around the pulleys or in the sag. This causes centrifugal tension in the whole belt. Every particle of belt while going round the arc of a pulley has a definite tendency, due to centrifugal force, to fly away from the pulley and thus lessen the grip or traction of the belt on the pulley. It is necessary to have a certain tension on the belt to get this tractive effect, which is caused by the grip of the leather on the pulley. Owing to centrifugal force, it is also necessary, especially at high speeds, to increase the initial tension sufficiently to overcome this tendency of the belt to fly away from the pulley.

The centrifugal tension is added to the tension already in the belt, causing it to stretch more and to stand off from the pulleys. This has the effect of not only reducing the traction on the pulleys, but also reducing journal friction. The amount of centrifugal tension would appear to depend on the weight per foot of the belt; doubling the weight per foot doubles the centrifugal tension. It also depends on the speed of the belt, and is proportionate to the square of the speed; doubling the speed multiplies the centrifugal tension four times.

At extreme speeds the centrifugal tension may become equal to, or greater than, the original tension, in which case the belt may be seen to stand off from the pulleys, touching them only at the top where its weight is supported. Under these conditions little or no power can be transmitted.

It is not proposed to labour the theory of belt-driving here, however, more than to convey some idea of the principles involved.

Grain versus Flesh Sides.

The question of whether a leather belt should be run with the grain or flesh side next to the pulley has been much discussed. The outside of a hide, let it be explained, is called the grain or hair side, while the inside is called the flesh side. Some contend that a closer contact with the pulley can be obtained by putting the grain side of the belt next to it, and it is sometimes claimed that 30 per cent. higher efficiency can be obtained in this way. Moreover, it has been contended that belts with the grain side to the pulley do not crack or break, thus prolonging the life of the belt.

Some years ago tests of the capacity of the grain and flesh sides of leather belts were conducted by the Leather Belting Exchange in its Research Laboratory at Cornell University. Covering a period of more than two months, continuous tests were run on testing apparatus using five 4-in. single belts, 30 ft. long, of different manufacture. They weighed from 16 to 18 ozs. per sq. ft. Every effort was made throughout the tests to standardise conditions and to reduce probable error to a minimum, and this unquestionably was accomplished. All five belts were run long enough, previously to the experiments, to have been thoroughly "run in," and had reached a condition of constant capacity when the records were taken. The method of procedure was to take horse-power readings from the first belts when running on the grain sides and then, when running on the flesh side, the power being gradually increased until about 4 per cent. slip had been reached.

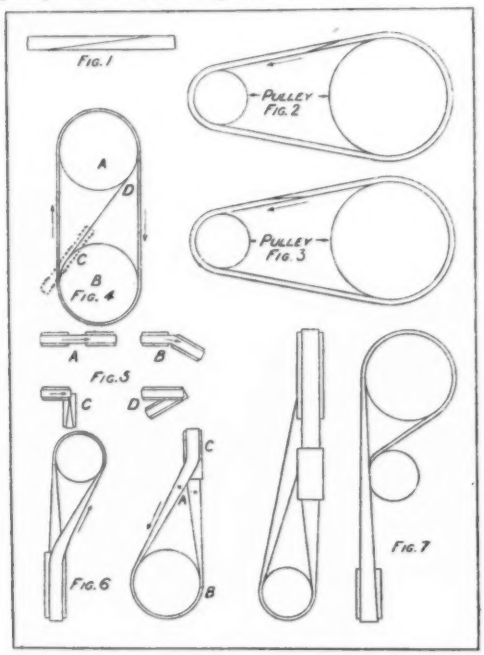
It must be remembered that a leather belt is at its lowest capacity when new, largely because of the elasticity of the leather and the newness of its surface. Leather belts are well stretched in the process of manufacture, so that, when the belt is put on the pulley, there may be as little stretch as possible consistent with thorough lubrication and retaining the natural life or elasticity, which is such a valuable property of the leather belt. When a new leather belt is placed on the pulleys, however tightly, it will elongate under load, but after the tension of the load has been removed, it returns very nearly to its original length. The stretch is an annoyance when installing a new belt, but it is of the nature of a safety valve, protecting both belt and machinery. The newness of the surface, however, makes it necessary to "run-in" the belt when testing it; that is, to run it for a sufficient time to permit the belt to attain a maximum capacity in transmission. As an illustration, one belt under test at the Cornell University transmitted 12 h.p. when first put on the pulley at a slip of 1.2 per cent. After five hours' running it reached 19 h.p. with the same percentage of slip and the same tension. At the end of 13 hours it transmitted 24 h.p. and reached 31 h.p. after 20 hours with a slip of 1.6 per cent. According to horse-power tables, its scheduled transmission should have been 26 h.p.

A summary of all the results obtained was clearly in favour of the grain side from the standpoint of power transmission. In fact, it may be concluded from it that, under reasonable tension, the flesh side will average only 50 to 60 per cent. as much horse power as the grain side. At higher tensions the flesh side will do better, averaging from 50 to 100 per cent. as much power as the grain, depending upon the belt, the tension, and other conditions.

In short, evidence produced from the mass of data obtained leaves no reasonable doubt but that there are distinct advantages in power transmission to be had from running leather belts on the grain side. It is simply another case where scientifically obtained evidence must outweigh arbitrary opinions held by reason of personal and, oftentimes, inaccurate observation.

Belt Speed.

Some very useful information was given in an Australian journal about two years ago on belt speeds. At high speeds the centrifugal forces induced in the belt, indirectly, result in increasing the pull on the driven shaft; for they cause a tendency in the belt to fly away from the surface of the pulley, thereby reducing the arc of belt contact. This reduction in arc contact renders necessary an increase in the tension required to give a constant amount of driving friction. Belts should have a tension when at rest of about 100 lbs. per in. of width of good double belting. If it is not practicable to measure the tension on the belt, a good working plan is to make the cut length of the belt 1 in. per 100 ft. less than the tape-measured length over the pulleys. On the other hand, over-tight belting must be avoided as it leads to burnt bearings. Finally belts should always sag on to the pulleys and never away from them.



For a single belt a reliable formula connecting the horse power which a belt of given width b can transmit at a speed v is given by the expression

$$\text{h.p.} = \frac{b \times v}{800}$$

A double belt will be capable of transmitting 1.6 times this power. The recognised equivalence between fabric and belting for transmitting a given horse power is four to one. In other words, a four-ply stitched canvas belt is equivalent to a single leather belt of the same width; eight-ply canvas equals a double leather belt, and so on.

The "flapping" of belting in pattern shops frequently becomes a source of annoyance. This usually arises either because the pulleys are out of line, or out of true, or the laced ends may not be straight. Sometimes lack of steadiness in driving speed, or too long a distance between the pulleys, is the reason. Where it is caused by running at too high a speed the use of a perforated belt will prove a remedy. There are, of course, other causes, but, generally speaking, a little attention directed to one or other of the points mentioned will remove the trouble.

In some cases the power transmitted to a shaft may be increased by using either a driving wheel or pulley of larger diameter, because the arc of belt contact is extended. Thus increasing the diameter of the driven pulley will enlarge its arc of contact, but at the same time it will decrease the arc of contact with the driving wheel; also, of course, the speed of the driven shaft is diminished and a greater torque is applied. On the other hand, an increase in the diameter of the driving wheel implies an enhanced rim speed and consequently a faster belt speed, so that a narrower belt may be used to transmit the same power.

How to Cover Pulleys to Improve Grip.

A very great deal depends upon the pulleys. A cast-iron pulley that has not been turned on the surface has not the grip of a polished surface, and a very dry belt has a tendency to slip, as it only bears upon the crown of the pulley. Wooden pulleys are said to have a better grip than iron ones, but if the iron is covered with leather—very seldom done in patternshops—an improved adhesion is obtained. It is claimed by some that where there is deficiency of power transmitted, 45 per cent. more work can be done on a machine, with the belt slipping, if the pulleys are covered with leather. To cover an iron pulley with leather the following course is recommended: Cut a piece of belting of the required length plus three or four inches for the joint, according to the size of the pulley, moisten the belt, causing it to stretch, but do not soak it entirely, and apply it carefully round the pulley, marking the exact circumference of the leather. Then with a sharp plane, taper or scarf the two ends so that they may join without producing an extra thickness. Join the ends with glue cooked in linseed oil or with any good waterproof cement. When dry the leather will require moistening again until it will go on the pulley. The same cement may be applied to the pulley and the inner surface of the belt previous to putting them together. The belt will shrink while drying and will fit tightly in place. The hair side of the leather should be on the outside. Woven belts have been applied to wooden pulleys as a covering and attached with glue cooked in skimmed milk that, when dry, is waterproof.

Joining Belts.

Surely in few workshops is the joining of belts carried out in a more careless fashion than in many patternshops. Long service cannot be expected of a belt when bad fastening methods are employed. Experience has shown that only for comparatively low speed and heavy main drives should a laced fastening be employed. Belts that run at fairly high speed and pass over small pulleys should not have a fastener that thickens or stiffens the joint, otherwise much slip will occur. Screws, rivets or metal plate fasteners are also not desirable in similar circumstances. The lighter and more pliable a belt is throughout its length, and particularly at its joint, it can, providing it is wide enough for its duty, be run much slacker than a hard, dry and inelastic belt and, moreover, transmit more power. There are of course practical difficulties in obtaining a jointless belt. The endless belt ought, however, to be more used than it is, as it naturally runs smoother. Fig. 1 shows the ends skived to a long, tapered, smooth, even surface, keeping the ends square with the edges. Depending on the width of the belt, the length of the lap can vary, and the following figures have been found to give excellent results: For a 1-in. width belt, length of lap 5 in.; 2-in. belt, 5 in.; 3-in. belt, 6 in.; 4-in. belt, 6 in. Generally before cementing a joint the belt should be placed over the pulleys and proper tension obtained by clamps.

Now with regard to the direction of travel of a lapped belt. Fig. 2 shows the most widely used method, but the argument in favour of running the lap with the outside edge pointing in the direction of travel as in Fig. 3 may be put succinctly thus:—The inner surface of the lap will be smoothed down in the case of excessive slippage, as slipping may start the scarfed end of the lap and cause it to roll up if the inside edge is pointing in the direction of travel. Fig. 1 is, however, the more reliable method.

Slipping and Belt Dressing.

In many, if not most, patternshops the only belt dressing used is resin, and it is used without limit. It is not satisfactory because, shortly after the ground resin is applied, the slipping restarts. It is dirty stuff to use; not only does the pulley become coated, but the resin collects in lumps on the belt and tends to crack it. Mineral oil should never be used, but there is much to be said for castor oil, which also keeps the belt soft and pliable and it need not be costly. An occasional application is sufficient. Any belt dressing should be used sparingly. There are proprietory belt dressings on the market and some of them are quite good.

In patternshops there is often trouble with the quarter turn belts from countershaft to machine.

A quarter turn belt is always a regrettable expedient. The simplest rule to remember in arranging quarter turn belts is, as the belt leaves either pulley it must lie in the plane of the other pulley. This rule applies not only to quarter turn belts, but to any angle from zero to 180 deg. and to any drive. To set one pulley at any angle with the other, retaining a running condition at the same time, a diagram like Fig. 4 is useful. Pulleys A and B are drawn as a common open belt drive and then the diagonal line CD is drawn. Holding the pulley A rigid, rotate the pulley B about the axis CD to any position or angle, and with the belt running in the direction indicated the condition of the foregoing rule will be fulfilled, *i.e.*, as the belt leaves either pulley it will lie in the plane of the other pulley. By turning pulley B through 90 deg., as is usual with quarter turn belts, it will occupy the position indicated by the dotted lines, and it is evident the belt will not run off the pulleys. Fig. 5 shows the application of Fig. 4 more fully for a number of angles where (A) is a common open belt drive. At (B) pulley B is turned through 30 deg., at (C) we have the quarter turn, and at (D) a turn of over 150 deg., and the conditions of the rule are fulfilled in every case. The next step would be a common crossed belt drive, so it is evident that the theory which was outlined in "Power" some ten years ago is very simple, but in practice we find it is not as easy as it looks, principally because the theories are incomplete and do not consider the weight of the belt at all.

Pulleys for drives of this kind should have plenty of crown, and they should be wider than the average pulley on account of the leading off angle A, Fig. 6. This angle is greater on pulley C than on pulley B of the same drive on account of the difference in their diameters, but when equal the angles will be equal. The pulley widths depend upon their diameters and the distance between shaft centres. The greater the distance between centres, the narrower may be the pulleys. In designing a drive it is best to lay it out on paper and see how great the leading off angle will be and select a suitable width—there can be no guesswork about it. Our best authorities state that no greater leading off angle than 25 deg. should be used. This occurs when the distance between shaft centres is equal to twice the diameter of the largest pulley.

The leading-off angle should be made as small as possible so as to reduce the fibre stresses and prevent undue wear. Quarter turn belts often wear rapidly because of grinding action at the point of leading-off, and the greater the angle, the greater this action will be. For this reason it is desirable not to use pulleys with leather coverings, or belts with high co-efficients of friction, so that the slip will take place with as little friction as possible.

A good kink in the operation of quarter turn belts is said to be to turn one end of the belt before lacing through 180 deg., so that both sides of the belt will come in contact with the pulleys and both edges will be stretched equally and the wear will be uniform all over.

As for the selection of pulleys and belts, the smaller the pulleys, the less will be the leading-off angle, but small pulleys are not so efficient. Large pulleys and a narrow belt, and as great a distance between pulleys as possible, make the best selection. The best belt speed for highest economy being from 400 ft. to 450 ft. per minute, the most economical combination of belt and pulleys may be easily determined by following the method employed for common open drives.

The Use of Idlers.

Fig. 7 shows a method sometimes employed to reduce the leading-off angle on the small pulley to zero by an idler, but an idler is always objectionable on the tight side of a belt because it absorbs some power. If an idler is used at all, it should be perfectly aligned, should not be too small, and should be nearly as frictionless as possible. It has been demonstrated in open drives that idlers properly designed and placed absorb almost zero power, and with quarter turn drives equally well designed and placed the efficiency should be just as great.

It must be noted that not one of the quarter turn drives shown in the sketches is reversible, because the belt when leaving the small pulley does not lie in the plane of the large one. But Fig. 1 could be made reversible by the use of another idler. Therefore a quarter turn drive should not be started backward or the belt will run off; it will run in one direction only.

The subject of belts is an engrossing one, but it will repay the power user to give time to the study of it, and it is undeniable that the efficiency of patternshop machinery depends very largely on the condition of the belts.

GROUP OF THE MEMBERS OF THE SCOTTISH BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN TAKEN DURING A VISIT TO THE WORKS OF DAVID COLVILLE & SONS, LIMITED.

A. F. CRAIG & COMPANY, LIMITED, of Caledonia Engine Works, Paisley, have removed their London office from 12, Old Jewry Chambers, E.C.2, to Abbey House, 2-8, Victoria Street, Westminster, S.W.1.

THE directors of Allen-Liversidge, Limited, have decided to offer to shareholders the balance of the unissued capital. Compressing stations are to be opened at Belfast, Manchester and Southampton, and one is also about to be erected at Glasgow. The authorised capital is £300,000, of which £244,135 has been issued.

Economy in Foundry Practice.*

By E. H. Browne, M.Inst.Brit.F. (London).

This Paper is an attempt to set out under one heading the various points of foundry expenditure, where money is often wasted, in the hope that some at least may see where they can improve their own shops and thereby show a larger margin of profit over existing conditions. It must be remembered that different foundries are working under different conditions, and the measure that gives the greatest output at least cost in one shop does not necessarily have the same effect in another, owing to differences in equipment and type of workmen.

Monotony in Foundry Practice.

The human element has much to do with economy in any factory, because all other operations are dependent upon it, and the shop that really stands the best chance of securing economical working is the one where every workman has an interest in the work he is doing and in the finishing of the contract. Where a man is constantly employed on the same job he loses interest in it; the monotony of his daily work takes away any interest he may once have had, and he is, to all intents and purposes, turned into a machine.

Mr. Gardom recently stated to the London Branch of the Institute of British Foundrymen that a greater output per man was obtained by employing the machine moulders to mix their own sand, fetch the cores and cast up than if they were confined strictly to the one operation of making moulds. It is only fair to state, however, that the machines in question were of the hand-ramming type, and therefore the question of costly plant lying idle and not doing its full output was of less importance than with other types of machines.

With the modern ideas of mass production and the rigid fixing of the rule "One man, one operation," all thought for the man often goes. A man who is employed on a job can turn out more work per hour if the monotony of the work can be broken; and whilst desiring to point out that true economy demands the utmost output from each machine and tool, that output will only be reached if the best can also be obtained from the men working them.

The interest of the men in some cases is very difficult, or often impossible, to obtain; what interest, for example, can the boys and men employed on making railway chairs, etc., see in their work beyond the pecuniary one produced by piecework rates? This state of affairs, however, is not by any means always present, and in the general jobbing foundry, the one that more often than not is worked on anything but an economical basis, and which offers large scope in this direction because of the variety of jobs and the small numbers to be made off each. Whilst agreeing in many ways with those who hold that full sequence of operations by different men is the best, yet it is insisted that in the foundry other factors have to be considered, particularly where intricate castings are being made. The train of thought required by the turner engaged on different pieces of work is not so heavy a strain as that of the moulder "coring up, venting, cutting the runners, etc.," for a mould. With the turner the only chance of spoiling his work is by taking a wrong cut, but with the moulder there are at least half a dozen different things to be guarded against, and with monotony entering too much into the work the tendency for wasters due to carelessness is certainly greater.

It is impossible in a general way to point out any golden rule for the application of men to the jobs in a foundry, because no two foundries are working under the same conditions.

Case of the Patternmaker.

With the patternmaker repetition work is largely absent, apart from the production of parts such as core prints and bosses, and the worker's interest is also gained by his knowledge of what the finished job will look like, what his particular part is for, and also by the large variety of jobs passing through his hands. The patternmaker both sees the drawing and understands it, but how often is either true of the moulder? The only way in which the moulder can be taught to take an interest in the machine for which he is constructing a part is to educate him during his apprenticeship to other sides of his work, then, as he gains experience and, provided suitable remuneration be offered for useful suggestions, he will be ready to rise to the occasion when a difficult job is in progress, and perhaps save large sums of money to the firm employing him.

Management.

A further factor greatly influencing the human element in the foundry is the management of the shop. A good foreman in a shop, possessing, in addition to practical and theoretical knowledge, the power to obtain the best from the men by personal influence alone, and without threats, is worth far and away more to the firm than many small foundries seem to think. There are many foundries in this country where a poor moulder is a foreman and made a greater success of it than a first-class moulder had done before, merely because the one could obtain from his men what the other could not.

The provision of boiling water in a foundry for the men who desire tea is an improvement to the shop well worth the investment. In the foundry where this is not done men can often be found in out-of-the-way corners sitting over a fire waiting for their cans to boil; also when the first metal of the day is cast there is often a rush to the furnace with hand ladles on the very reasonable and often true excuse of wanting a special grid or chill for a rush job, and thereby disappears a spare 7 lbs. of metal to provide a head on which to boil some more water. Similarly, if facilities are not provided for warming the men's lunches then cores are turned out of the stove half an hour before lunch in order to utilise it for the purpose.

As regards smoking in the shop, the author thinks that similar conditions apply; certainly the lavatory accommodation is not nearly so full in the shop that permits smoking as in the one that does not. If the men are allowed to smoke at work, half, or more than half, of the inducement to go outside or to sit over the ladle fires has gone.

Lay Out of Foundry.

The question of the lay-out of the foundry and the provision of suitable places for the various classes of work cannot be studied too deeply.

If a water tap is very slightly out of place much money can be lost through it in the course of a year. If, for instance, it lies a few feet back from a pathway the space in front has got to be kept clear, the room is wasted, and, moreover, becomes a sort of dumping spot for small quantities of old iron, etc., which subsequently have to be moved again, and whilst lying there are often the cause of a man tripping up and hurting himself. Certainly, water tanks provided with a protected ball tap have great advantages, provided that a further tap with hose coupling be added.

The arrangement of power house, mains, etc., are questions that are usually determined by force of circumstance, and in most cases little can be done to improve matters in an existing foundry. In a new one much can be done to prevent loss of power in the air mains and cupola blowing arrangements. This question of air mains is one that cannot be considered too carefully. Most foundrymen are fully aware of the high cost of compressed air, yet how often does one hear the sizzling away of money in some little-used corner of an old foundry. It is evident that if the cost of air were compared with the cost of a proper inspection of the pipe lines, the latter would become far more frequent.

The position of the cupolas or melting furnaces is of considerable importance, but once again is

* A Paper presented to a Congress held in connection with the recent Foundry Trades Exhibition.

often the victim of circumstance. If the crane service in the shop is dislocated as soon as metal is required the work of the whole shop is held up, and for this reason it will often pay in a foundry to put up a small auxiliary cupola in some other place where light work can be cast without causing interference.

The position of the foundry store and its supervision is of great importance. How often in some foundries does one see a moulder looking half-way over the shop to find clamps, gaggers, wedges, etc., merely because when last used they were thrown down and forgotten. The time taken to put the used articles away is generally just about a third of that required to find them if they are mislaid A central store, with separate bins for each article, is a necessity for good foundry organisation.

Equipment.

The provision of an adequate supply of boxes of the various sizes required for the general run of shop work, particularly for moulding machines, is a necessity. For a machine it will often be found best to provide sufficient boxes of the most frequently used sizes to absorb a day and a half's output of the machine. In a shop that does not cast on Saturday, Monday afternoon often becomes a slack time for a machine-hand, because he has used all his boxes and waits for the metal to free some again.

Holding-down weights, clamps, etc., demand a fairly liberal supply. The actual cost of making good weights is very small, and when substituted for rough pigs or bent-up rods very soon pay for themselves. A stack of two tons of pig-iron for weighting-down machine flasks takes longer to handle, is more dangerous, and occupies more room than weights of a good section and convenient size.

The equipment for dealing with untempered sand is, in many foundries, deplorable. New facing and core sands require careful milling and mixing, and suitable plant must be provided. For dealing with floor sand, machine riddles are greatly to be desired, for not only is the sand better mixed, but the loose sprigs, core irons, etc., can be removed all together instead of being picked out one by one as the labourer turns over each shovelful, missing each time a lot which once again are picked out by the moulder as he rams up the flask. In many ways it is an economy to have a special staff of men for dealing with the used sand and adequate transport facilities for its delivery from place to place.

Machines, particularly those for moulding purposes, the author strongly recommends the avoidance of pneumatic power where possible. For small pressure type moulding machines the cost of power for operating is very much cheaper with the hydraulic type, the actual difference depending very largely on the efficiency of the air mains.

When it comes to installing a new machine in a foundry, more often than not the question of cost is the deciding factor. Founders appreciate the value of the better machines even at double the cost; but even to-day the tendency still is for the engineer who knows little or nothing of the subject to do the actual purchasing, and, provided the traveller is sufficiently pressing, the simplest machine will generally be the one ordered.

Care of Foundry Plant.

Engineers as a whole have the idea that the foundryman badly uses any piece of plant he obtains, and ruins them by neglect. This, no doubt, is true in some cases, but the author still holds the opinion that moulders in general take more care of their tools than do some of the engineering departments.

It cannot be too strongly urged that the best machinery, and not the cheapest, is what really pays in a foundry. Mechanical wear is undoubtedly extremely heavy, but modern machine designers have done much to overcome this difficulty, and the founder himself can do still more.

As to the type of machine that can best be installed in any foundry, individual considerations must first be studied and little more can be said in a general way regarding machines, beyond mentioning the fact that many different snap flask machines for small work are to be had which efficiently overcome the question of stocks of boxes lying idle when different sized plates are put on the machine.

The installation of sand-blasting plant, emery wheels and pneumatic tools, together with oxy-acetylene cutters and welders, are serious questions. In a large foundry the sand blast, efficiently used, is undoubtedly an economy both from the engineer's and foundry points of view. The same may be said of emery wheels, irrespective of the size of the foundry. The author has known large shops in more than one district in this country where the fettler has to go to the machine shops to find a wheel on which to sharpen his chisels. Surely such a state of affairs would not be tolerated elsewhere than in a foundry.

It is always a struggle to get the men to use pneumatic tools for fettling and incidentally for ramming moulds in a foundry; though when once brought in they generally stay. The question of welding plant has been mentioned because the time has come for the repair of castings in this way. Repairs can often be made to minor parts either by "burning on" or by welding, and engineers may rest assured that even if such operations are not done before their faces there is much done behind their backs.

The efficient heating of core stoves would go a long way to produce greater economy in many old foundries. The old method of a coke fire piled up to the top and burning itself out has been and still is, in very many cases, the only way of heating. Such stoves are often lacking in efficient ventilation and have been the cause of many bad castings by reason of improperly dried cores and moulds. There are many modern designs for core stoves, and the cost of conversion from old type to new will generally be repaid under the twelve months.

Provision of Moulding Tools.

As to the actual hand equipment for the men, an adequate supply of hand, peg and flat rammers is necessary, and if good ones are not provided, rough cast ones are made by the men themselves. Most moulders prefer a forged rammer to a length of rod with a "blob" cast on the end; once made, these tools last, and the cost is very small. Shovels should be provided to the extent of one per man; if this is not done the cost of these tools is increased. The men in the foundry prefer a part-worn shovel, and where each man has his own all are kept in better condition than when each is handled by two or three.

Ordinary moulding tools should be provided by the moulders, though it will often be found advisable to supply the most necessary ones, viz.:—trowel, heart and square, ½ and ¼ in. cleaners, boss tool, spoon tool, top edge, etc., to the apprentices. This will be the means of producing both better work and more of it. A tool-box might also be provided, for if not, quite a lot of the lads will get one made by another boy in the pattern shop, who will utilise the firm's time, timber and screws, etc., in the production of them; moreover, more time is spent in making the tool box if it is being done on the sly than if done openly, and really the author fails to see any gain. The confidence of the lads—a thing greatly to be desired with the dearth of apprentices—is certainly gained by providing them with these few necessaries, which, after all, only cost together about ten shillings.

Design.

A large amount of money is often wasted in the foundry by bad design. In many cases this would be prevented if the draughtsman had some practical knowledge of the principles of foundry practice. For most work a matter of a very few months' working knowledge of foundry details would suffice, but with special jobs it is only by studying exactly the method of moulding, the points for runners and risers, etc., that the strongest and most economical casting can be designed.

Failures due to bad design are of somewhat frequent occurrence in a foundry, examples, such as large bosses on thin sections of metal, awkward arrangement of cores, etc., have come to the notice of most moulders. Cases where a hollow has been required in a casting with no provision for core vents or aperture for removing the core after casting, have in more than one instance come to the notice of the author, in each case

XUM

much time has been spent in finding out where a vent could be left without detriment to the finished job.

By adequate co-operation between the foundry manager and the draughtsman jobs would be made easier for the moulder, and very often also for the pattern-maker. Loose pieces on the pattern can often thus be avoided and greater taper allowed, both of which facilitate moulding and thus reduce costs.

Patterns.

The pattern shop as a rule obtains far more attention from the engineer than the foundry: the shops are often, though by no means always, better lighted and equipped and generally in a better position for economical production than the foundry.

When dealing with the construction of a pattern it should always be borne in mind that expenses incurred in the pattern shop occur only once for each pattern made, whereas those of the foundry occur once for each casting. If this fact were borne in mind more when cheap and rough patterns are being made the total cost of a batch of castings would often be greatly reduced. A few roughly shaped pieces of wood held together by nails are all that is required for a one off job, but as soon as numbers run up to 20 or more, then the best-made pattern, with dovetailed, instead of screwed on loose pieces, halved joints and proper runners, is the one that will come cheapest in the long run.

The varnishing of patterns that are required for more than two or three castings will pay for itself in the ease of stripping from the sand, and the provision of separate colours for patterns in different metals or different mixtures, as well as the marking of core prints and machined surfaces, saves much time in both pattern store and foundry.

Where many castings are required off a pattern, the choice of the material in which to make it is one requiring some thought; for small work white metal or brass will often be the most suitable, while for larger castings mahogany or some other hard wood will generally be the most economical in the long run. For machine moulded patterns the provision of some form of pattern plate is usually necessary. A very satisfactory material for this purpose is cast iron, which undoubtedly has the advantage of cheapness and is quite satisfactory, providing that care is taken to oil or varnish the pattern after use and before putting into store.

Moulding.

When a pattern reaches the foundry, or even before that, very careful attention should be paid to the method of moulding, particularly as to whether it be suitable for moulding on a machine or not. In this respect it will often pay to put small quantities of a pattern on to a machine because of the better lift thereby obtained and the smaller amount of patching required.

As to whether to cast a particular job in loam, green or dry sand, the discretion of the manager must here play a large part, coupled with the quantity of tackle available, or that it becomes necessary to make. For large castings the author prefers dry sand as being slightly cheaper, but it must, however, be remembered that it is easier to get an accurate casting as well as to cast in any particular way in loam than in dry sand. The finishing of a mould surface can often play some part in determining finished costs by reducing the time required to clean the casting. This is particularly true with intricate castings and those of somewhat heavy section that are inclined to eat into the sand. A light dusting with plumbago or wash with oil in parts will do much to help matters.

Melting.

The melting of the metal for a casting is one that requires great care, as well as does the selection of the proper mixture for a particular casting, especially in the steel and brass foundries.

Dealing first in a general way with those questions affecting cost, the proper lining of the furnace is most important, and in every case the best lining for the purpose will work out cheapest in the end.

As to fuel, local conditions have much to say in this matter, and no generalities can be made.

In the brass foundry the gas- or coke-fired tilting furnace is one of the best types. The makers usually recommend the smaller sizes for economical melting.

For steel the merits of the electric and open-hearth have to be separately considered, and the choice must be made with a view to the particular work in hand.

In the iron foundry choice is practically limited to the cupola; as to the different types, really expert opinion varies so much that no particular recommendation can be made, each being capable of good attainments in expert hands. As to the most economical methods of running a furnace, excellent treatises have been often written on the subject, which requires more lengthy treatment than can be given here.

The stocks of metal for melting purposes, whether iron, steel, or brass, require to be kept separately and preferably in separate lockers, so that there is no possibility of two similar-looking materials getting mixed, and moulds and castings thereby spoilt. This matter is particularly necessary with pig-iron and the special cupro alloys, though in the latter case price alone generally secures the attention which is often absent in so far as pig is concerned. Many a batch of castings has been spoilt because the wrong metal was used; with a properly organised stock yard or store this should be impossible.

Determination of Costs.

The costing of each casting that comes out of a foundry is a very important factor, particularly where jobbing work is done. It is only by actual knowledge of costs that prices can be satisfactorily given for work, and moreover, it is through detailed costs that leakages and extra costs can be traced and measures promptly taken to remedy matters.

To those who contemplate introducing new costing systems care should be taken to see that the new system introduced is in complete harmony with the rest of the office routine. If this is not done matters are likely to clash in one way or another and little good would be the result.

Conclusion.

In conclusion, the author points out that the subject is by no means exhausted. Several headings alone have been treated and many are the smaller details which could have been included. It is hoped that many of these will be brought forward in the discussion to the benefit of all.

American Work on Testing of Foundry Sands.

Dr. H. Ries, chairman of the sub-committee on the American Geological Survey of Foundry Sands, reports in the *A.F.A. Bulletin*, that the sand testing being carried on at the Bureau of Standards at Washington and at Cornell University is progressing very favourably. Up to date the two stations, jointly, have completed the tests on about 353 samples of sand. In addition, the Ithaca station has about 75 samples half completed. It is expected that the tests on all the samples will be finished not later than the end of June, at which time the test data will be ready for publication by the A.F.A. and by the Geological Surveys of the several states submitting samples.

The testing work is being carried out under the supervision of the Joint Committee on Moulding Sand Research, four assistants being employed by the committee, two assistants doing the work at each of the two stations. There are eleven states in all, and a total of 632 sand samples.

Ougrée-Marihaye.—This concern reports profits for 1923 amounting to 42,305,179 francs (approximately £450,000), compared with 19,250,235 francs in 1922. It is proposed to pay a dividend of 100 francs per share, against 50 francs in 1922.

The Chilean Ironworks.—The works of the Compagnie des Hauts Fourneaux, Forges et Aciéries du Chili are reported to be still at a standstill, pending an understanding with the Chilean Government. Various proposals are being examined for the utilisation of the works at Corral. The exports of ore from Tofo, which amounted to 297,000 tons in 1922, reached 673,000 tons in 1923, and have risen to 525,000 tons in the first half of this year.

Trade Talk.

MR. PERCY GRIFFITH, consulting engineer, has removed from 20, to 39, Victoria Street, London, S.W.1.

VIVIAN & SONS, LIMITED, have removed their London offices from 9, Basinghall Street, to 4, London Wall Buildings, E.C.2.

THE LONDON & NORTH-EASTERN RAILWAY COMPANY propose to close down the old-established locomotive works at Springhead, near Hull.

AUSTRAL METALS, LIMITED, 27, Old Broad Street, London, E.C.2, has been granted a licence under the Non-Ferrous Metal Industry Act, 1918.

MR. E. DAWSON, aluminium refiner and non-ferrous metal manufacturer, has removed from 29, Warwick Road, to 70, Foleshill Road, Coventry.

THE ETNA IRON AND STEEL COMPANY, LIMITED, of Motherwell, have removed their London offices from 7, Union Court, Old Broad Street, to 67-8, Broad Street Avenue, Blomfield Street, E.C.2.

MR. HARRY W. DIXON, of 3, Newton Road, Leeds, who has represented the Carnforth Hematite Iron Company (1915), Limited, Carnforth, for many years, has severed his connection with that company, and is now representing the Millom and Askam Hematite Iron Company, Limited, Millom, Cumberland, for the sale of their brands of pig-iron known as "Millom" and "Askam."

MILLARS' TIMBER AND TRADING COMPANY, LIMITED, Pinners' Hall, London, E.C.2, have decided to transfer the whole of their machinery business to a separate organisation specially adapted to deal with it, and a new company has been registered for this purpose under the title of Millars' Machinery Company, Limited. All the shares of the new company are owned by Millars' Timber and Trading Company, Limited. The head office will remain at Pinners' Hall and the works at Kirtling Street, Battersea, S.W.8.

THE BUSINESS OF Charles Parker, Sons & Company, Victoria Foundry, Dundee, has been taken over by the associated companies Fairbairn Lawson Combe Barbour, Limited, of Leeds and Belfast, and Urquhart Lindsay and Robertson Orchar, Limited, of Dundee. The business thus taken over will be carried on by a separate company, the directors of which will be Mr. J. K. Anderson (chairman), Mr. J. C. Inglis, Mr. Charles Parker, Mr. William Parker, and Mr. H. L. Whalley.

THIRTY-FOUR REPRESENTATIVES of 12 unions in the light castings industry in England and Scotland met representatives of the National Light Castings' and Ironfounders' Federation at Rotherham, on June 27, to discuss the unions' application for an advance of 15s. per week. The employers refused to concede the advance, and the unions' executive councils will consider the position separately and report to a conference of the unions on July 15, when a decision as to strike action will be taken.

Personal.

MR. LAWRENCE FEAY has been placed in charge of the Manchester branch at 24, Lever Street of Richard Johnson, Clapham & Morris, Limited.

MR. H. G. FLETCHER has severed his connection with Frank Graham & Company, steel and non-ferrous metal merchants, Collingwood Street, Newcastle, with whom he has been associated for over 30 years, and will shortly start business on his own account.

MR. W. A. CHRISTIANSON has joined the engineering sales staff of Hick, Hargreaves & Company, Limited, of Bolton. He formerly held appointments with the British Thomson-Houston Company, Limited, and W. H. Allen, Sons & Company, Limited, Bedford.

ON RETIRING after having completed 41 years' service in the Callendar Iron Company, Limited, Falkirk, Mr. Thomas Scott, works manager, has been the recipient of a handsome presentation from the directors and employés. Major Hay, chairman of directors, made the presentation. Mr. Scott, in returning thanks, pointed out that he had served during three generations of the Hay family.

MR. H. I. LEWENZ, who recently resigned his appointment with Vickers, Limited, and Mr. J. W. Wilkinson, electrical power engineer, late of 12, Tavistock Street, W.C., have joined forces as managing directors of a private company, to be known as Lewenz & Wilkinson, Limited, with offices at 25, Victoria Street, S.W. The new firm will be principally concerned with the application and supply of power plant and equipment for industrial purposes generally, including exhauster and blower plants and pneumatic conveyors.

Will.

HOLDGATE, W., of The Tower, Glossop, Derby, iron merchant £6,012

Obituary.

MR. ALFRED WALKER, who had been manager for 32 years of Messrs. Thomas Bolton's copper works at Froghall, died recently at the age of 60 years.

MR. P. SUMMERSKILL, one of the principals of the engineering works of Summerskill Bros., Sowerby Bridge, was killed at the works last week. He was 60 years of age.

MR. G. KEIGHLEY, who died at his residence, "Koonah," Simonstone, recently, aged fifty-one, was a director of George Keighley, Limited, Bankhouse Ironworks, Burnley.

MR. W. CROOKE died at his residence, Fern Villa, Oswald Road, Scunthorpe, last week, at the age of 84. A native of Lancashire, he was for many years engineer at the Millom and Askam Ironworks, and while there patented the Massicks and Crooke hot blast stove. He took up his residence at Frodingham in 1909, and with the assistance of his second son, Mr. Arthur Crooke, general manager of the Frodingham and Appleby Works, he patented Crooke's revolving top for blast furnaces.

MR. J. P. ACHURCH, the senior managing director of Parker, Winder & Achurch, of Birmingham, died at his residence, "Stukeley," Farquhar Road, Edgbaston, recently. Mr. Achurch, who was the third son of Mr. John Achurch, was born in 1859 at Brampton, Hunts. He went to Birmingham in 1880, and became associated with the late Mr. Henry Parker. In a comparatively short time Mr. Achurch was admitted into partnership in the firm which was then known as Parker & Winder, and subsequently styled Parker, Winder, & Achurch. In 1903 he was elected a member of the Birmingham Committee of the Royal Metal Trades Pension and Benevolent Society, and was subsequently elected vice-chairman.

Company News.

C. F. Wilson & Company, Limited, 166, Constitution Street, Aberdeen.—Capital £10,000 in £1 shares. Oil, gas and internal-combustion engine manufacturers.

Gibbons (Dudley), Limited.—Interim dividends on preference and ordinary shares, 7 per cent. per annum, free of tax.

Kayser, Elison & Company, Limited.—Until actual result of company's working is known it is not proposed to make any payment of preference dividend.

Martletts, Limited, Marconi House, Strand, London, W.C.—Capital £6,000 in 5,000 10 per cent. cumulative preference shares of £1, and 40,000 ordinary shares of 6d. Engineers. Directors: G. C. Isaacs, F. W. Gauntlett, Viscount Cobham, H. B. Vogel, M. H. P. R. Sunkey, C. E. E. P. Sunkey, and S. F. St. J. Steadman.

Mond Nickel Company, Limited.—Final dividend, 1s. 6d. per share on ordinary shares, making 2s. 6d. per share, less tax, for year.

Gazette.

MESSRS. A. WHITEHEAD and A. LAKIN, carrying on business as engineers, at 9-13, Victoria Road East, Leicester, under the style of Whitehead & Lakin, have dissolved partnership, Mr. A. Whitehead continuing.

THE ASTRA STEEL & IRON COMPANY, LIMITED, are being wound up voluntarily. Mr. J. T. Raybould, 115-117, Colmore Row, Birmingham, has been appointed the liquidator of the company.

Contracts Open.

Rugby, July 14.—3,124 yards of 4-in. and 3-in. cast-iron water mains, for the Rugby R.D.C. Mr. J. E. Weeks, surveyor, Hillmorton Paddox, Rugby. (Fee, £3 3s., returnable.)

Garth and Fron-Cysyllte, July 26.—Provision and laying of 562 yards of 4-in. and 1,662 yards of 3-in. cast-iron mains, 2,450 yards of 2½in. wrought-iron mains, 933 yards of 2-in. wrought-iron mains, etc., for the Llangollen R.D.C. Berrington, Son & Watney, Prudential Chambers, Lichfield Street, Wolverhampton. (Fee, £5 5s., returnable.)

THE NEGOTIATIONS with a British firm for the construction of 500 miles of railways in Poland which were nearing a successful conclusion, are now for the time being at a standstill, owing to the fact that the British firm makes it a condition that the major part of the rolling stock and rails shall be supplied from England. The Polish steel industry resents this, as it is passing through a partial crisis. It is considered likely that a compromise may be reached.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Business in the Cleveland iron market is far from satisfactory at the moment, and with an extended holiday period in view, it is difficult to anticipate an improvement in conditions until towards the close of the current quarter, when autumn requirements may bring a brisker demand. In the meantime stocks in makers' yards are steadily accumulating in the absence of home and export demand.

LANCASHIRE.—The local markets for foundry pig remain in the same state of depression suggested in previous reports, only a small amount of iron changing hands, the usual price asked being 101s. to 101s. 6d., although occasionally it is said that makers have accepted as low as 100s. for No. 3 foundry, delivered equal Manchester.

THE MIDLANDS.—South Staffordshire furnaces report that there is a very slight improvement in the call for foundry iron at the reduced prices previously indicated.

SCOTLAND.—Conditions in the principal markets for foundry pig continue dull in view of the approaching Glasgow Fair holidays, and there is keen competition for even the smallest order in circulation.

Scrap.

Buying in the scrap material markets at present is practically suspended, or at most is confined to small lots of metal to meet urgent requirements. In Lancashire dealers are still quoting 90s. delivered for good lots of broken machinery metal, but they are fully aware that in the near future they may have to sell at 85s., or perhaps at 80s. The foundry trade in Lancashire cannot be brisk enough to absorb all the scrap which is coming into the market until there is a revival in textile engineering and in house-building, for these two industries account for a large proportion of the castings made in the district.

Metals.

Copper.—The position in the standard market remains practically unchanged, but at the close of last week there were signs of a weaker tendency in values. The situation in America is also regarded as disappointing, stocks tending to accumulate in spite of regulated output; and on the Continent, where not only is consumption restricted for lack of buying power, but second-hand parcels are still offered for export at comparatively cheap prices. However, as previously suggested, the present price is low, and the market is ready to respond to even a slight improvement, either in sentiment or in the situation generally. Current quotations :—*Cash* : Thursday, £60 17s. 6d. ; Friday, £60 15s. ; Monday, £60 15s. ; Tuesday, £60 12s. 6d. ; Wednesday, £60 12s. 6d. *Three Months* : Thursday, £61 17s. 6d. ; Friday, £61 15s. ; Monday, £61 15s. ; Tuesday, £61 12s. 6d. ; Wednesday, £61 12s. 6d.

Tin.—On the whole, a firmer tendency has developed in this metal, and values show an advance on quotations last week. The market, however, remains in a rather sensitive condition, and prices are easily moved in either direction within moderate limits. The recent recovery, under all the circumstances, has been well maintained, and a fairly firm undertone prevails.

Ricard & Freiwald's statistics of tin are appended :—

STOCKS, LANDING AND AFLOAT, EUROPE AND AMERICA.—United Kingdom : Stocks in London, 1,081 tons ; stocks in other ports, 2,091 ; total, 3,172 tons ; landing and in transit, 760 tons ; afloat from Straits, 1,390 tons ; afloat from Australia, 125 tons ; total United Kingdom, 5,447 tons. Holland : Banka spot, 1,091 tons ; Banka and/or Billiton afloat to Europe and America, 1,417 tons. Continent : Straits afloat, 1,420 tons. United States : Spot and landing, 4,067 tons ; afloat, 6,000 tons ; total visible supply, 19,442 tons.

Current quotations :—*Cash* : Thursday, £225 10s. ; Friday, £225 5s. ; Monday, £225 10s. ; Tuesday, £225 ; Wednesday, £222 10s. *Three Months* : Thursday, £226 ; Friday, £226 ; Monday, £226 15s. ; Tuesday, £226 5s. ; Wednesday, £224 5s.

Spelter.—The market for this metal, under pressure of bear covering, has developed some irregularity, but a better inquiry from consumers is in evidence. Rudolf Wolff & Company report that spelter producers on the Continent show no disposition to press sales, and the comparatively small lots that were offering from Germany have been sold or withdrawn. The market, on the whole, seems in a sound condition, but the situation in America, containing, as it does, the possibility of export sales being made on a fairly extensive scale, tends to exert a restricting influence on prices. Current quotations :—*Ordinary* : Thursday, £31 17s. 6d. ; Friday, £31 15s. ; Monday, £31 17s. 6d. ; Tuesday, £31 15s. ; Wednesday, £31 17s. 6d.

Lead.—The market for soft foreign pig has become rather more sensitive, with an uncertain tendency. This may be partly due to the troubles which threaten in the building trade, and which exert a depressing influence. Arrivals in this country have recently been heavy, but the near position seems more dependent on the state of the bear account, whilst forward is governed largely by the position in Mexico and prospective supplies from that quarter. Current quotations :—*Soft foreign (prompt)* : Thursday, £32 7s. 6d. ; Friday, £32 ; Monday, £31 15s. ; Tuesday, £32 2s. 6d. ; Wednesday, £32 17s. 6d.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Mixing and Judging Pig-Iron.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I was extremely interested in Mr. Young's comments on the methods of mixing and judging pig-iron, published in your issue of July 3. I do not think any reasonable metallurgist can disagree with the major portion of Mr. Young's remarks as now stated.

IN focussing attention on carbon content Mr. Young is doing a signal, if belated, service. The only elements worth worrying about in the normal cast iron are total and graphitic carbon. Yet these two features are those which are most neglected in every-day practice. The percentage of combined carbon, *per se*, has no influence on strength, and is only of interest in iron to resist wear.

Graphitic carbon is what really matters. May I crave space to republish some results I obtained on electric furnace cast iron a year or two ago to better demonstrate this point?

	(1) Per cent.	(2) Per cent.	(3) Per cent.
Total carbon	2.71	2.89	2.91
Graphite carbon	2.45	2.53	2.19
Combined carbon ...	0.26	0.36	0.72
Silicon	3.15	2.64	1.86
Sulphur	0.086	0.092	0.102
Phosphorus	0.093	0.868	0.36
Manganese	0.71	0.53	0.41
Tensile Strength.	Tons.	Tons.	Tons.
1″ diameter cast bar ...	17.10	16.60	19.9
Transverse Test.	Cwt.	Cwt.	Cwt.
15″ × 1″ × 1″ cast bar ...	38	41.2	47.0
	Ins.	Ins.	Ins.
Deflection	0.19	0.14	0.18

The results need no comment. Unfortunately for the foundrymen, total carbon is one of the most difficult of figures to control, hence the selection of pig-iron by hand. I should not like to see the present American system of selling pig-iron to analysis put into operation in this country, as the total carbon content seems to be utterly disregarded. When one finds a brand of pig-iron which has a suitable analysis and price, and (what is more important) one which can be relied upon to be consistent, delivery after delivery, especially in total carbon content, one should by all means adhere to it, and I doubt whether Mr. Young is as free and easy in his choice of pig-irons as he would have us believe he is.

Regarding fractures, the variation in fracture due to the causes enumerated by Mr. Young is not so great as he would have us believe.

Presumably, no self-respecting metallurgist should even glance at a fracture, and should pass a pile of pig-iron in the yard with his head strictly turned the other way. Personally, I find the study of fractures both interesting and valuable, as they form very often a useful check on the analysis, and are practically the only guide in purchasing scrap.

Mr. Young's remarks on the estimation of carbon contents in cast iron are a slur on the metallurgical profession, which I do not think is justified. At any rate, Mr. Young might attempt some constructive criticism, and indicate to those less well-informed the methods he adopts for estimating the various forms of carbon in cast iron.

In conclusion, may I congratulate Mr. Young on his excellent little Paper, but assure him that we should all love him better if he were not, like Eustace, "so blooming wholesale."—Yours, etc.,

FRANCIS W. ROWE, B.Sc.

Park Works, Lockwood, Huddersfield.
July 7, 1924.